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Fossil Collecting in Pennsylvania

Donald M. Hoskins

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF INTERNAL AFFAIRS
Genevieve Blatt, Secretary
BUREAU OF
TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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BULLETIN G 40

Fossil Collecting in Pennsylvania

by Donald M. Hoskins
Paleontologist

Illustrations by Albert Van Olden

PENNSYLVANIA GEOLOGICAL SURVEY
FOURTH SERIES
HARRISBURG

1964

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Fossil Collecting in Pennsylvania

by

Donald M. Hoskins

INTRODUCTION

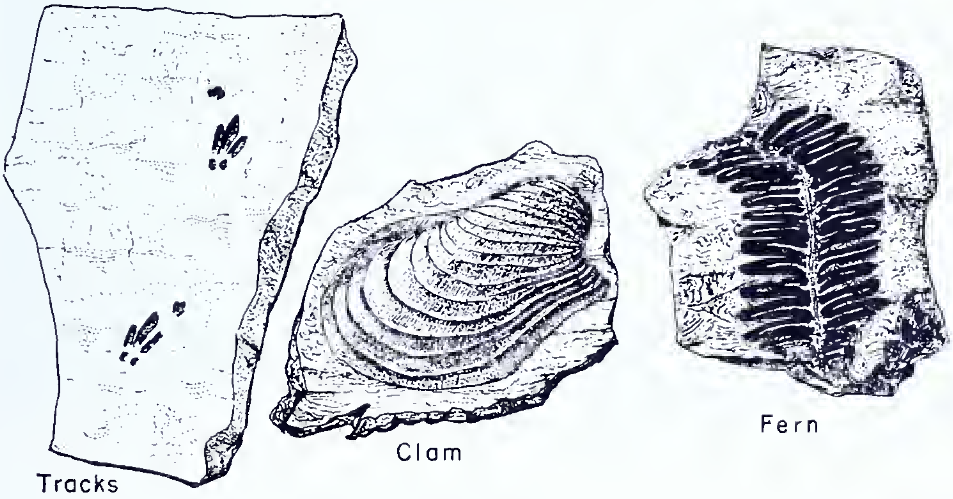
Frequently the Pennsylvania Geological Survey receives requests for information on where to collect fossils. This booklet is intended to supply such information, thus the major portion of the booklet is devoted to a description of fossil localities and the fossils to be found at each locality.

There is more to fossils than just collecting them. The study of fossils (Paleontology) is the life-time work of many scientists. Their work has given answers to some of the basic questions of life and the world we live in. To have a comprehensive understanding of what fossils signify gives the collector a greater appreciation of the hobby in which he is engaged. To enhance this appreciation, a portion of the booklet is devoted to the meaning and uses of fossils as well as the description of the major groups of fossils that one may encounter. For those interested in further information on Paleontology, references are given near the end of the booklet.

WHAT IS A FOSSIL?

Fossils occur in many forms. The footprint of an animal preserved in rock is a fossil; a clam shell preserved in rock is a fossil; the imprint of a leaf in a rock is a fossil. A fossil is any naturally formed record of animal or plant life found in rocks that gives an idea of the appearance of the original organism.

Imagine for a moment a clam. A clam is composed of two shells surrounding a fleshy body which contains muscles that open and close

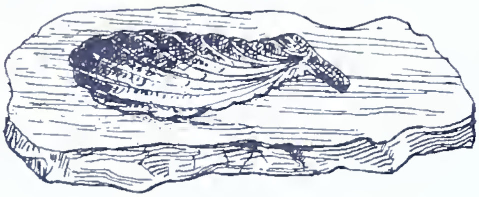


the shells. If we examine the various things that may happen to this clam after it dies, we will learn the many ways in which the clam can be preserved as a fossil.

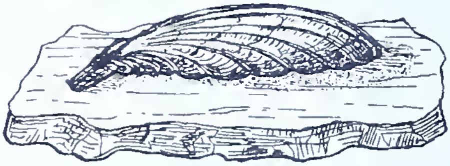
When the clam dies the soft parts decay and disappear and the shells are left to be washed about on the sea bottom or shore. Because the muscles that held them together are gone the shells frequently separate. The shells may be destroyed by currents on the sea bottom, or they may be buried beneath sediments which continually accumulate on the sea floor. Burial by sediments is the first step in fossilization.

The sediment surrounding the shell may become compacted and turn into hard rock, and the shell may be preserved with no further changes. On the other hand, many shells are dissolved away by the water in the compacted sediment and a hole is left that becomes a *mold* preserving all the details of the shell surface. If other material later fills this hole and hardens, the hardened material becomes a *cast*. Both casts and molds are fossils because, although nothing of the original animal is left, we can tell what it looked like. Since the outside and inside of a shell generally look different, we call molds and casts internal (inside) and external (outside) depending on which part of the shell they show. Molds are common as fossils, casts are relatively rare.

MOLD



CAST



If the clam escapes being dissolved it may be affected by further processes as the rock around it hardens. One of these processes is *replacement*. Most hard rocks when examined microscopically are found to contain many very small pores and spaces. The pores and spaces may be interconnected and may contain water carrying dissolved minerals. Under certain conditions, minerals carried by this water will be substituted for the shell material (commonly calcite) so that the shell is gradually replaced with minerals such as quartz or pyrite.

Some animals, such as insects, possess no hard parts (skeleton or shell); their body covering is made up of an organic compound called chitin which is similar to our fingernails. These animals, when buried, are preserved under only the most exceptional circumstances whereby the chitin, by a process called *distillation*, is reduced to a thin carbon film as the sediment is compacted. This film may preserve many of the very fine features of these animals.

Representatives of the plant kingdom are usually found as two types of fossils. One is the imprints of leaves, ferns and seeds that have been carbonized by the distillation process discussed above. Limbs, roots, and trunks of trees are many times preserved as casts and molds; rarely, large portions are preserved through replacement of plant tissue and filling of pore spaces by silica and other minerals. This is *petrifaction*. The trees found in the Painted Desert and the Petrified Forest of the American West are examples of this process.

The track made by the dinosaur, as it stopped by a stream to drink, and the trail of the crab, skittering along the seashore, when preserved in rock, are also fossils because they give us an idea of what the feet of the animal looked like.

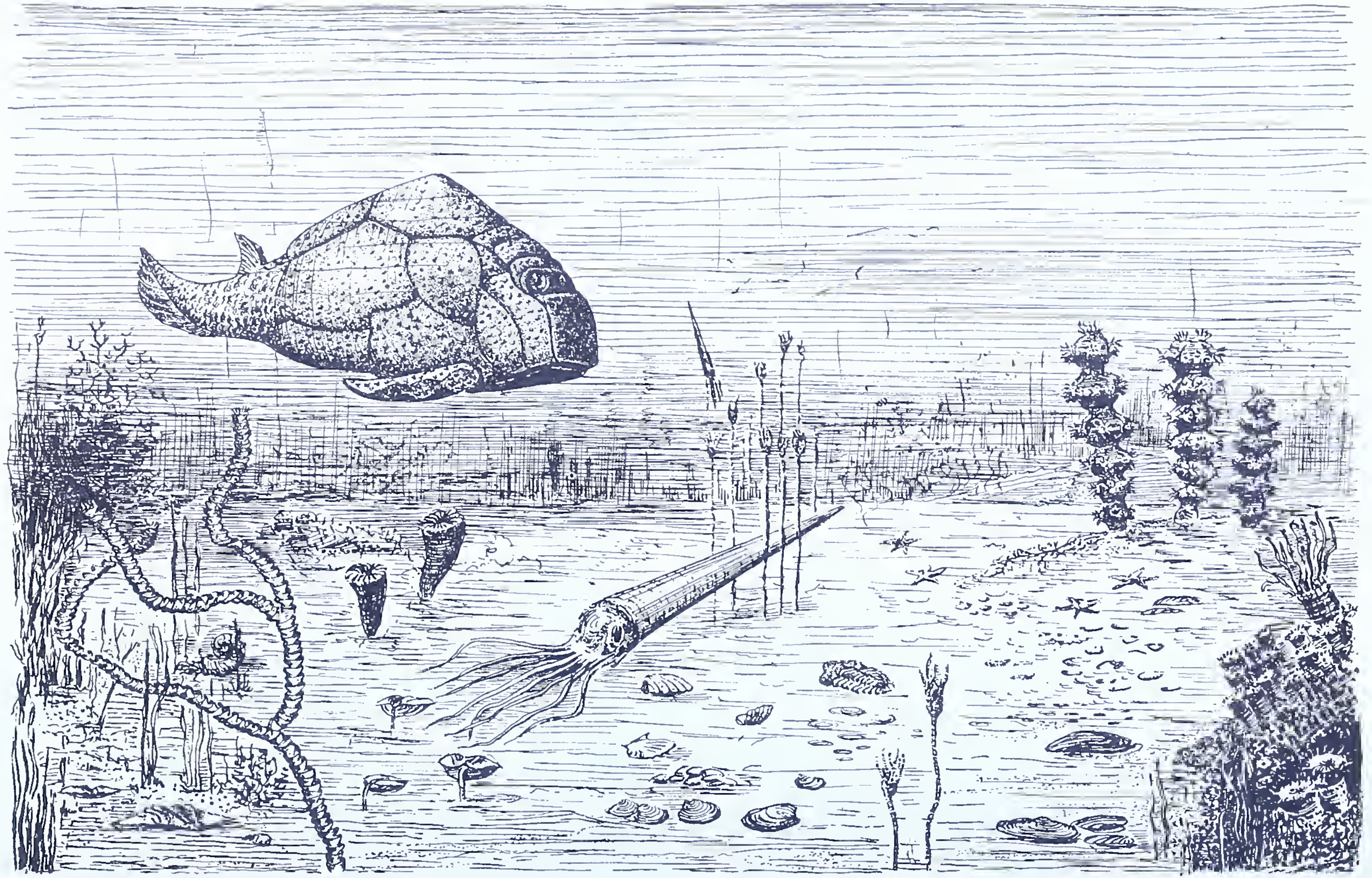
Preservation by *burial* in sediment is one of the most important factors in the formation of a fossil. Many organisms do not die in places where sediment is being deposited and thus have no opportunity for fossilization. The possession of hard parts is also very important in the formation of a fossil. Animals and plants live today for which there are no known fossil ancestors. These ancestors lacked hard parts, died where no sediments were being deposited, or a combination of these two factors.

One of the most interesting studies a paleontologist undertakes is the reconstruction of the original animal or plant from the fragmentary fossils he finds. In many cases this is a very difficult procedure because the various fragments of an individual animal or plant are widely scattered and the skin, muscles and other soft parts are missing. It is often necessary to refer to living animals and plants to learn how to reconstruct a fossil. Many fossils have been found that cannot yet be reconstructed because they have no living relatives to which they can be compared. After reconstruction of a number of different fossils from the same age and environment, scientists often attempt to place them together as they once must have lived. A Devonian sea bottom scene (Figure 1) is an example of this.

It is important to remember in collecting fossils that what you discover is usually only a fragment or impression of the original animal or plant, lacking its soft parts and frequently lacking other hard parts that fit with it. It is also important to remember that the fossil organism that you discover is only one out of perhaps millions of similar individuals that may have lived.

OF WHAT USE ARE FOSSILS?

Why study fossils? Are they more than just curiosities? The answer is yes. Fossils are the record of life on the earth back in time through millions of years. As such they offer clues not only to the history of former life, but to the character of past climates on the earth and to



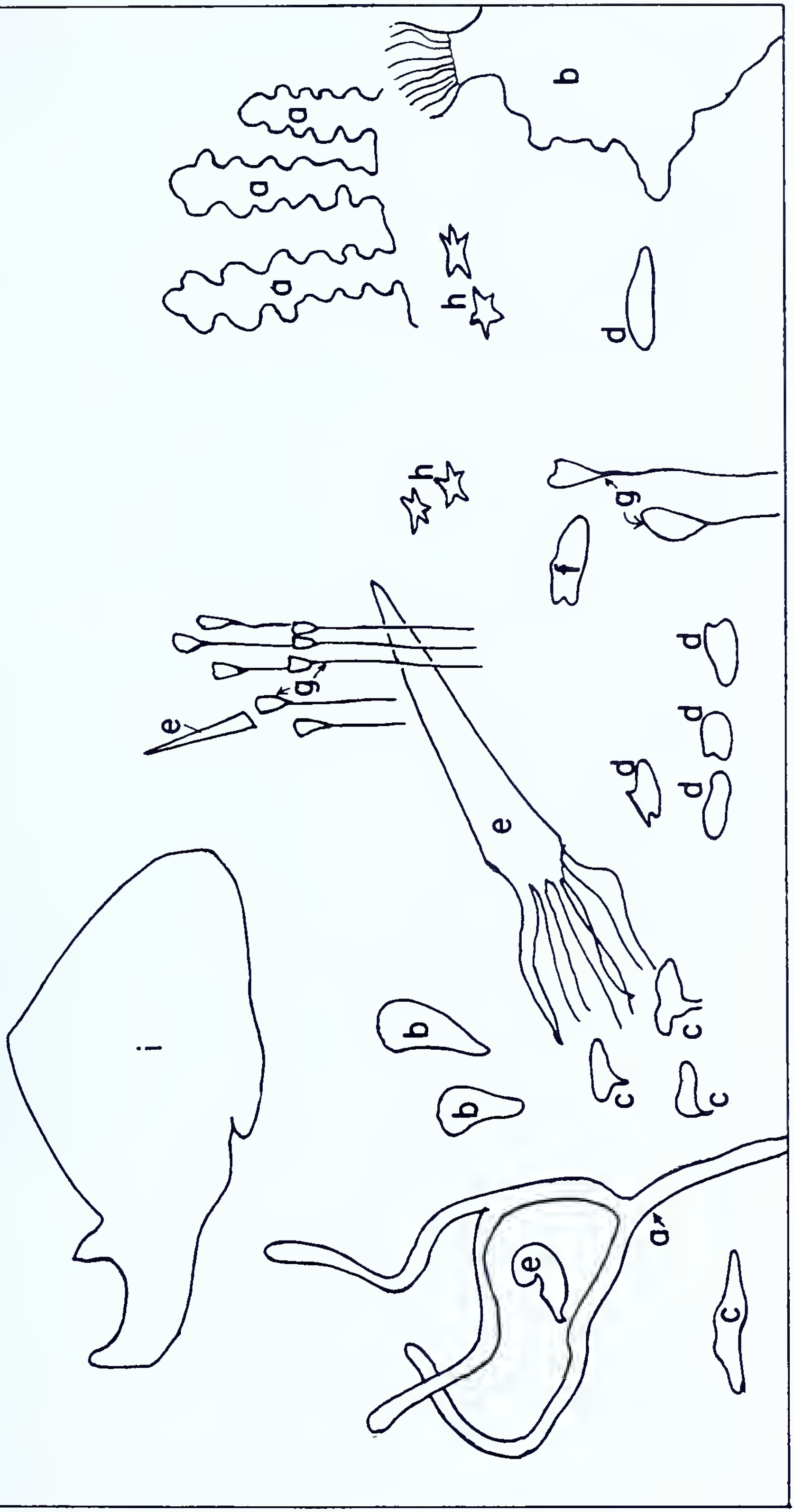


Fig. 1. A reconstruction of a Devonian sea bottom.

- a. "glass" sponges
- b. corals
- c. brachiopods
- d. pelecypods
- e. cephalopods
- f. trilobite
- g. crinoids
- h. starfish (stelleroids)
- i. armored fish (placoderm)

changes in the earth's surface and its seas. Because fossils yield information about the environment in which they lived, they also tell us something about the history of the rock in which they are buried. Knowledge of the rock history has practical use in the search for mineral resources such as oil and gas.

The oldest known rocks of sedimentary origin contain only certain primitive fossil animals. As younger and younger rocks are examined, it is found that the fossils they contain gradually change and become progressively more like present day living organisms. Detailed study of the changes of the fossils show that certain groups gradually changed (evolved) into later groups. These data support the *theory of evolution,* a theory with which scientists are much concerned.

The discovery that younger rocks contain different fossils than older rocks provides a method for dating and identifying rocks in different areas. If a paleontologist finds rocks in North America and South America that contain the same fossils, he can generally say that they were formed at the same time and thus are the same age.

The paleontologist working for the oil company does the same thing, only on a much smaller scale. He may work with rocks that only are in Pennsylvania. If he has fossils from a oil-producing well drilled near Pittsburgh and drills another well in Clearfield County he can use the fossils to tell the driller when he is approaching rocks of the same age as those in the Pittsburgh well. This may help in determining how deep one has to drill before intersecting the oil-bearing rocks.

How do fossils help us to unravel the history of the earth? The paleontologist has been able to determine for most types of fossils the conditions under which they lived. Corals, for example, obviously lived in the sea. When a coral is found in a rock, it follows that the rock must have been laid down in a sea bottom. By collecting a large number of fossils from all rocks of a given age, those areas occupied by land and sea of that time can be discovered. For example, the area of land and sea existing in Pennsylvania 365 million years ago has been worked out in this way and is shown in Figure 2.

Plant fossils, like animal fossils, also tell their own story. Trees grow on the land surface. Certain assemblages of plants and trees are characteristic of swamps rather than dry land. The coals of Pennsylvania are composed of trees and plants from such assemblages indicating that the coal forming times were times of extensive swamps in Pennsylvania (see Figure 42).

Fossils can be used also to indicate past climates on the earth. Corals, for example, are thought to have lived only in warm waters, as they do today. Prehistoric corals found in Alaska would indicate that Alaska was at one time in the past an area of warm seas.

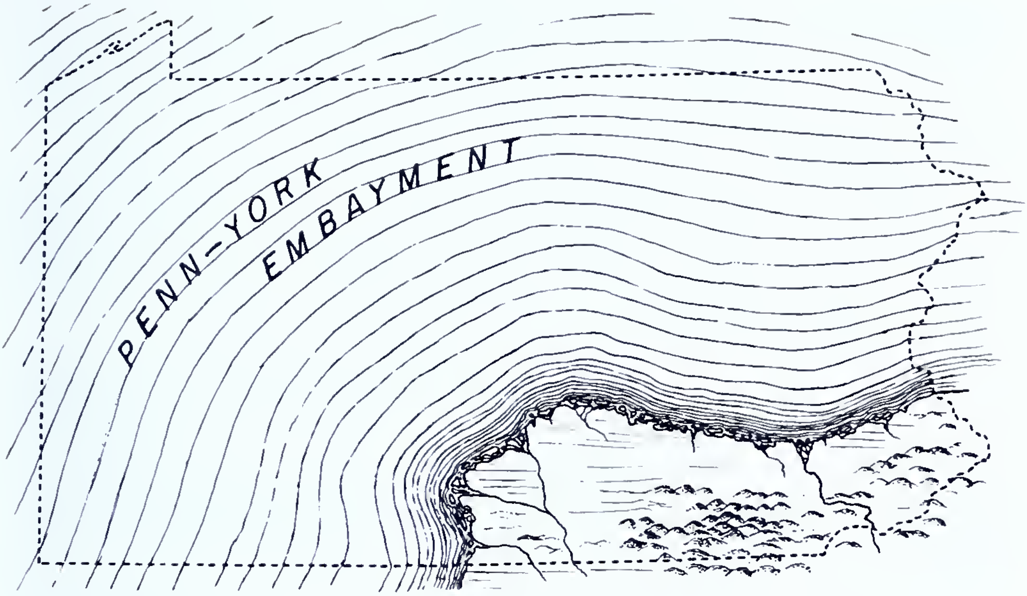


Fig. 2. Land and sea areas in Pennsylvania during Devonian time.

FINDING FOSSILS

While fossil-bearing (fossiliferous) rocks are present in most areas of Pennsylvania, fossils are not always easy to collect. They are found only in sedimentary rocks such as limestone, shale, and sandstone, and then only in a small fraction of these. If you are a beginning collector, you are advised to visit known localities first to become acquainted with the types of rock which contain fossils and to find out what fossils look like.

This book describes fossil localities in 63 of Pennsylvania's 67 counties. A small location map shows you how to find each fossil site. The Pennsylvania highway map and topographic maps may further aid the collector in finding the localities described.

In addition to data on location of the fossil sites, information is given under each locality on the names of fossils known to occur at each place, the type of rock and its age, and other information that may be of use to the collector. It is expected that careful searching at any locality will uncover fossils not given in the lists.

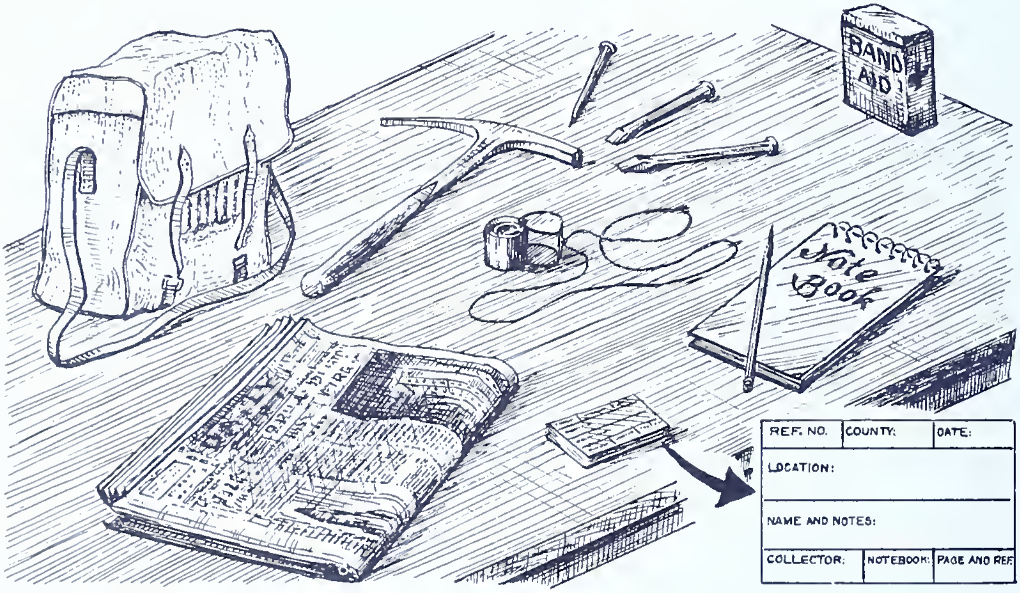
For the ambitious collector, the 1960 edition of the Geologic Map of Pennsylvania will be of great aid. This map shows the many rock formations throughout the state. If a formation or rock unit is found to contain fossils at one place, it is likely to contain fossils elsewhere. After learning which rock units contain fossils, refer to the map to find other areas underlain by the same rock units.

COLLECTING AND PREPARING FOSSILS

The collector is well advised to take with him to the fossil locality a hammer, newspapers, and a collecting bag. A hand lens is useful when the fossils are small.

A hammer with a chisel edge such as that used by bricklayers is most convenient for both breaking rock from the outcrop and for splitting the sample along natural layers. Rock will be encountered which is weathered so that it will be fragile and easily broken. At another locality, it may be fresh and very difficult to break.

Specimens uncovered in the field should be wrapped in layers of paper to preserve them and may be carried most conveniently in a collecting bag. Most importantly, specimens should be labeled when they are collected with the locality and any other pertinent information which will allow the specimens to be properly identified at a later date. A sample label such as that used by the Pennsylvania Geological Survey is shown below.



After the fossils have been collected it is often necessary to clean them by removing dirt and rock layers which may be hiding part of the specimen. It is advisable to wash the non-fragile specimens with water and then to work on the rock with various chipping and scraping tools ranging in size from cold chisels to fine needles depending on the size and fragility of the fossil. Old dental probes, if you can obtain them, can be sharpened easily into needle and chisel points that make very useful tools in cleaning fossils. Fragile specimens can be protected with a coating of clear plastic spray or clear nail polish.

When individual fossils have been cleaned and prepared, identification labels should be made out for each specimen giving, in addition to the locality, the fossil's name and the name of the collector.

Remember that in many cases the site at which you are collecting is on private property. *Obtain permission from the owner before you collect. Do not destroy fences or other property and do not leave litter.* Other people may want to visit this site and careless or heedless actions on your part may destroy this opportunity for them.

One of the best virtues a fossil collector can have is patience. Many of the very best specimens that have been collected come from sitting in one spot at a fossiliferous outcrop and patiently examining each piece of rock for fossils.

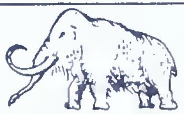
IDENTIFYING AND CLASSIFYING FOSSILS

A fossil collecting expedition is complete only when the fossils found have been given their proper names. All fossil plants and animals can be classified into progressively more limited categories until a generic and specific name (genus and species) can be applied to any individual specimen. The first step, a simple one in most cases, is to decide if the fossil is an animal or plant (Kingdom Animalia and Kingdom Plantae). Then the fossil is placed into its proper phylum (plural: phyla) and class. Classes are subdivided into families and families into orders; these are mainly of interest to scientists and are ignored here. The section of this book entitled Characteristics of the Major Fossil Groups will help you place your specimen in the proper categories.

The final refinement of the identification is to determine the genus (plural: genera) and species of the specimen you have found. All individual specimens of the same species may not look exactly alike, but they will have certain features in common. This you can see by observing individuals of the species to which you belong *(Homo sapiens)*. You can best identify the genus of the fossils you collect by comparing them with pictures of fossils from the correct phylum and class. The plates at the back of this book illustrate most of the fossils you are likely to encounter at the localities in this book.

Fossils on these plates are generally not shown at their actual size. The amount of reduction or enlargement is shown under each fossil picture. The figure X.8 means that the picture is eight tenths the size of the actual specimen. Keep in mind, however, that all specimens of the same genus will not be the same size. Fossil illustrations not shown on these plates may be found in any of a number of books listed in the Additional Reading section near the end of this book. One of the most useful references is "Index Fossils of North America" by Shimer and Shrock.

GEOLOGIC TIME SCALE

MILLIONS OF YEARS AGO	LIFE RECORD TYPICAL FOSSILS	ROCK RECORD PREDOMINANT ROCKS	GEOLOGIC NAMES PERIODS	ERAS
1		Glacial deposits	QUATERNARY	Cenozoic Era
		EROSION Sands & Clays	TERTIARY	
65		EROSION Sands & Clays	CRETACEOUS	Mesozoic Era
135		EROSION	JURASSIC	
180		Shales & Sandstones Diabase intrusions	TRIASSIC	
230		EROSION Shales, Sandstones, Coals, & Limestones	PERMIAN	Paleozoic Era
280			PENNSYLVANIAN	
310			MISSISSIPPIAN	
350		Shales, Red beds, Sandstones, & Limestones	DEVONIAN	
405			SILURIAN	
425		Shales & Sandstones	ORDOVICIAN	
500		Limestone & Dolomite Sandstone	CAMBRIAN	
600	ALGAE	EROSION Granites, Gneisses, & Schists	PROTEROZOIC ERA	Precambrian Time
			ARCHEOZOIC ERA	
4000+	ORIGIN	OF	THE EARTH	

Three examples of organisms are given below to show how they would be classified into various categories. The names may seem strange because they are based upon Latin and Greek words, but this has been done so that the names may be used and pronounced all over the world.

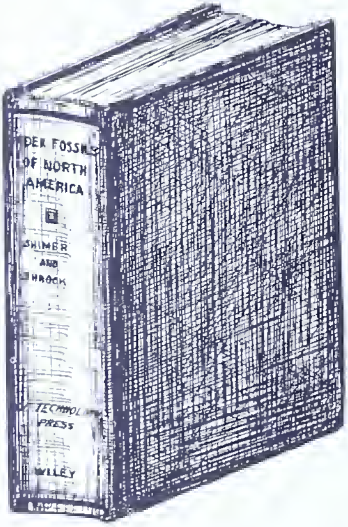
Category	*Example #1*	*Example #2*	*Example #3*
KINGDOM	Plantae	Animalia	Animalia
PHYLUM	Spermatophyta	Brachiopoda	Chordata
CLASS	Gymnospermae	Articulata	Mammalia
GENUS	*Pinus*	*Atrypa*	*Homo*
SPECIES	*strobus*	*reticularis*	*sapiens*
INDIVIDUAL	White pine tree	Sea shell	Man

It is common practice to simplify frequently used names by dropping or changing endings. For example, members of the Phylum Brachiopoda are called brachiopods; members of the class Mammalia are called mammals. The generic and specific names are not generally used informally and are always written as you see them above.

GEOLOGIC TIME

The earth has been in existence for over 4000 million years. To be able to talk about portions of this vast amount of time scientists have separated it into divisions (called Eras and Periods) which are characterized by certain kinds of fossils. In fact, fossils were one of the original means by which the boundaries between these various time divisions were established. The accepted time divisions are shown on the Geologic Time Scale (opposite page). The first column shows the ages at which the various periods started. The second column indicates some of the animals and plants that lived in these periods of the earth's history. The third column shows the many types of rocks formed in Pennsylvania during certain periods of time. If you will notice, during the Jurassic and most of the Cretaceous Periods, Pennsylvania was a land region and no rocks were formed here. Thus we have no record in Pennsylvania of the life that lived during these periods. The fourth and fifth columns list the names that scientists give to the various divisions of time. As you can see, it is much easier to say that you found a Devonian fossil than that you found a fossil between 350 and 405 millions years old. The era and period names will be used a great deal in later portions of this booklet. The colored map in this part of the book is a geologic map of Pennsylvania showing the areas in the state underlain by rocks of the various periods.

The Geologic Time Scale is the standard to which scientists refer in dating the various portions of the earth's past history. Using this standard we can study what occurred all over the world at any one time. The periods and eras represent, in general, times during which certain major events took place, such as the formation of a range of mountains. Many long and detailed books have been written on the subject of Geologic Time and the many geologic events that have taken place. For those interested in this fascinating subject references are given under Additional Reading.



GEOLOGIC MAP OF PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
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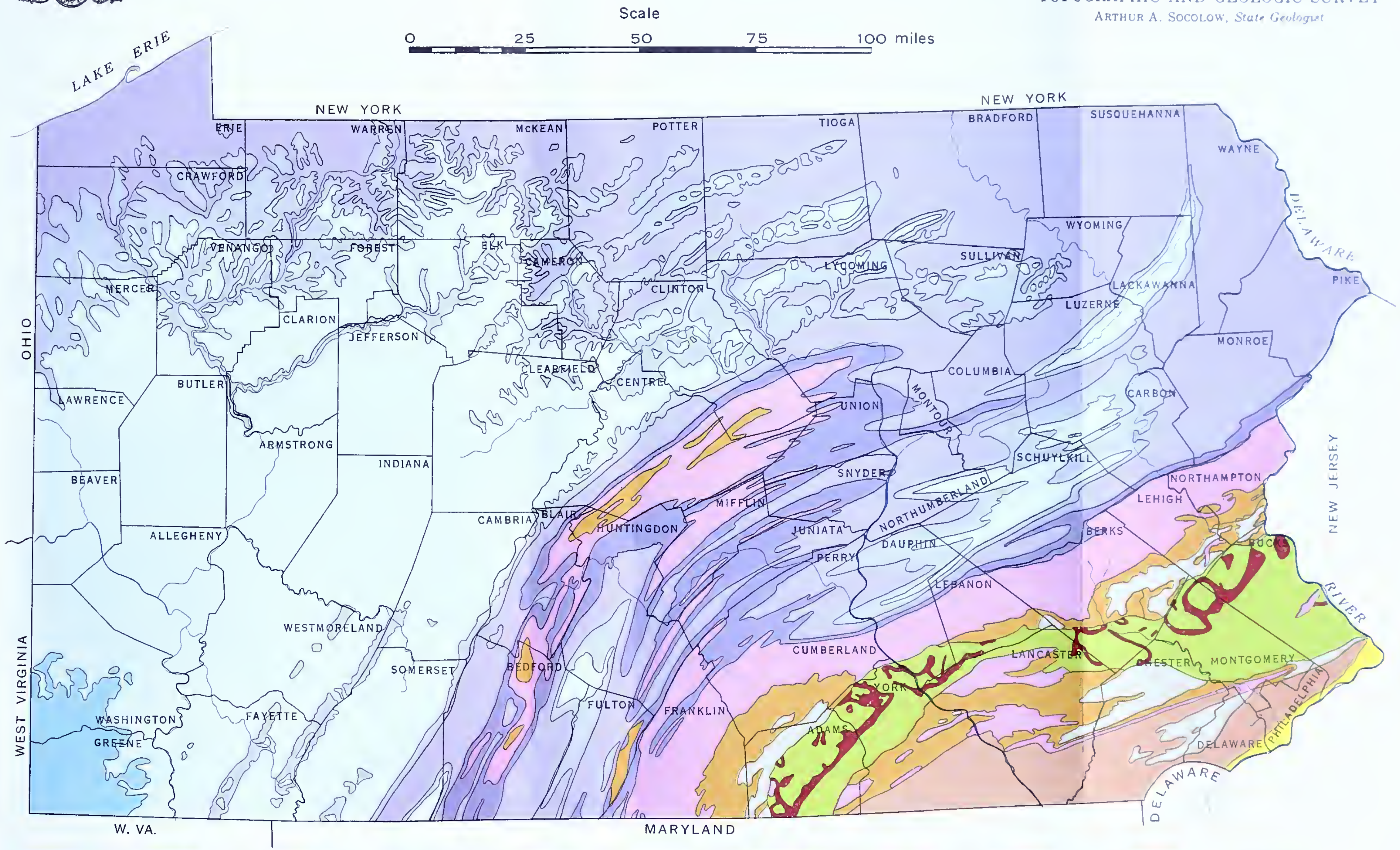


🟨 **QUATERNARY**
(0-1 million yrs.)
Sand and gravel.
sand and gravel.

🟩 **TRIASSIC**
(180-230 mil. yrs.)
Shales and sandstones intruded by diabase. (red)
iron, building stone.

🟦 **PERMIAN**
(230-280 mil. yrs.)
Cyclic sequences of sandstone, red beds, shale, limestone, and coal.

⬜ **PENNSYLVANIAN**
(280-310 mil. yrs.)
Cyclic sequences of sandstone, limestone, shale, clay, and coal.
coal, clay, lime.

⬜ **MISSISSIPPIAN**
(310-350 mil. yrs.)
Red beds, shale, and sandstone.

🟪 **DEVONIAN**
(350-400 mil. yrs.)
Red beds, shale, sandstone, limestone and chert.
silica sand.

🟪 **SILURIAN**
(400-425 mil. yrs.)
Sandstone, red beds, shale, and limestone.
gannister, lime.

🟪 **ORDOVICIAN**
(425-500 mil. yrs.)
Shale, limestone, dolomite, sandstone.
slate, limestone, zinc.

🟫 **ORDOVICIAN and/or CAMBRIAN**
(425-600 mil. yrs.)
Metamorphic rocks-schist, serpentine, gneiss and quartzite.
Building stone.

🟧 **CAMBRIAN**
(500-600 mil. yrs.)
Limestone and dolomite; some sandstone and shale.
lime and gannister.

⬜ **PRECAMBRIAN**
(Older than 600 mil. yrs.)
Gneiss, greenstone, serpentine and anorthosite.
zinc, building stone, graphite, serecite.

CHARACTERISTICS OF THE MAJOR FOSSIL GROUPS

INTRODUCTION

The animal Kingdom is divided into approximately 22 separate groups called phyla (sing. phylum). A phylum is a group of organisms thought by some to have originated from one common ancestor. Only 10 of the 22 phyla are represented by abundant fossils and thus are of great importance to the paleontologist. The other 12 phyla lack hard parts and are rarely found as fossils. The phyla which are important because of their fossils also contain many subgroups not found as fossils. Only those subgroups that have fossils will be discussed.

The plant Kingdom is composed of four major divisions. The term phylum is not applied to these divisions because they are not defined in quite the same way as are the animal phyla. One group, the division *Tracheophyta*, produced almost all of the fossil plants found in Pennsylvania.

KINGDOM ANIMALIA

Phylum Protozoa

Protozoans are simple, one-celled animals that include such forms as the *Amoeba*. They are found by the uncountable billions in our sea water where they provide much of the food for many other large aquatic animals.

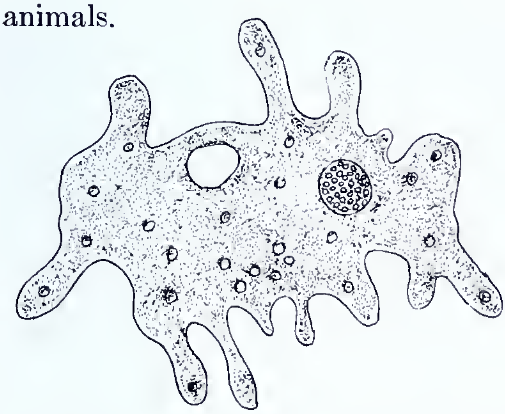


Fig. 3. *Amoeba—a living protozoan.* (x 50)

Only a few subgroups of the Phylum Protozoa are found as fossils because most of the animals in the phylum form no hard parts. The most important of these belong to the Class Sarcodina and are called Foraminifera or "forams" for short. These microscopic one-celled animals secrete (build) a shell around their body out of chitin (organic compound like your fingernail) or calcium carbonate; some make their shell out of sand particles. A large portion of our deep sea bottoms are covered with the minute shells of these animals.

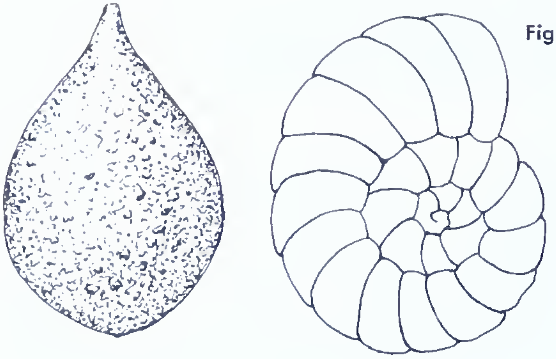


Fig. 4. *Lagenammina* (left) and *Endothyra*—foraminifera genera. (x 85)

Most of the forams are so small that they can be seen only with a high-power microscope. A few, however, have built a shell up to 6 inches across and are a major part of some rocks. The limestone that was quarried to build the great pyramids of Egypt is made up largely of the genus *Nummulites,* one of the largest that ever lived. One family of the forams, the Fusulinidae, secreted shells about the size and shape of wheat grains.

Foraminifera are not a common fossil of Pennsylvania, but fusulinids have been found in the Pennsylvanian Period Vanport limestone in the western Pennsylvania region.

Phylum Porifera

The Phylum Porifera (meaning pore-bearing) is the group of simple, many-celled animals we call sponges. Sponges have many shapes, ranging from ball-shaped to flask-shaped, and leaf-like forms. These animals consist of fleshy material with numerous pores supported by a rigid or semi-rigid internal skeleton. The skeleton of a sponge is made up of many very tiny pieces called *spicules* composed of calcite or silica, or fibers composed of spongin, a protein compound containing sulphur. The common bath sponge, used until recently, is the fibrous spongin skeleton of the genus *Euspongia.*

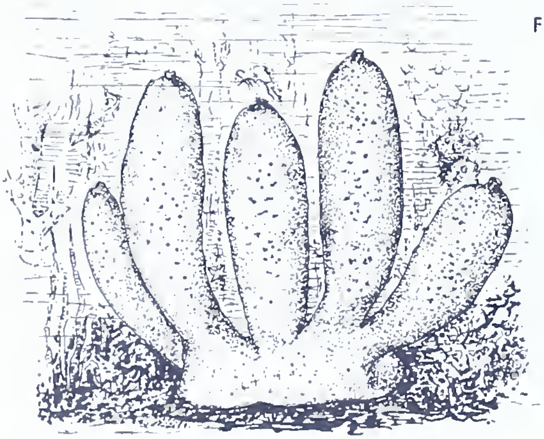


Fig. 5. Sycon—a living marine sponge. (x 2)

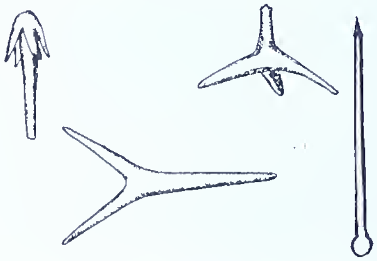


Fig. 6. Sponge spicules. (x 15)

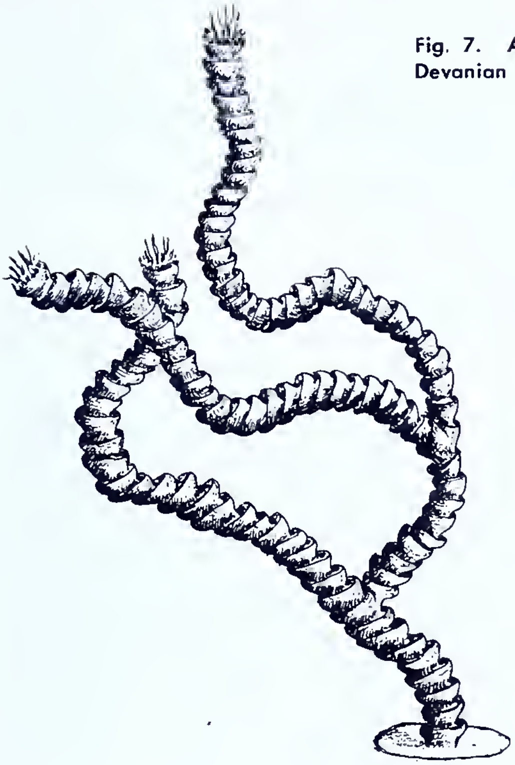


Fig. 7. A reconstruction of *Titusvillia*, a rare Devonian glass sponge from Pennsylvania. (x ¼)

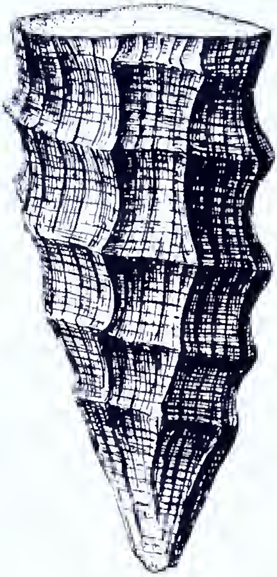


Fig. 8. *Hydnoceras*—a Devonian glass sponge. (x ⅓)

Sponge fossils generally are very rare because the spicules that form the skeleton fall apart soon after the death of the sponge; those without spicules have even less chance of preservation because their skeletons of fibers are rapidly destroyed.

There are three classes of sponges, all of which have fossil representatives. However, most fossil sponges in Pennsylvania belong to one class. This is the Class Hyalospongia (glass sponges). Even in this class fossils are rare but in some areas of northwestern Pennsylvania molds of the skeleton showing the characteristic mesh of the spicules are found. They are found in the Devonian and Mississippian Period rocks of this area. Separated spicules are also found in other rocks, but special techniques are required for their collection.

The Hyalospongia have a skeleton composed of an intricate network of siliceous spicules. The skeleton was flask-shaped or tubular and covered inside and out with fleshy layers. (See Fig. 1.) When the animal died, the fleshy material disintegrated and the skeleton was filled and covered with mud. Because the siliceous spicules were strongly interconnected and hard, their shape was impressed in the mud and was thus preserved as molds. The silica disappeared by being dissolved.

Phylum Coelenterata

The Phylum Coelenterata is a large group of animals, including the corals, that live mainly in sea water. The phylum includes many forms, both living and extinct, that superficially do not look much alike. Many of these groups within the phylum have almost no fossil record, while others have no living representatives.

Corals make up the largest part of the phylum and are well known from the large reefs they make near islands in tropical and subtropical seas. Also included within the Phylum Coelenterata are jelly fish, sea pens, sea fans, sea feathers, and a host of other forms.

There are two general body types in this phylum. Any of the coelenterates which has a rounded, bell-shaped body that floats and is carried about by sea currents is called a medusa. Tentacles hang from its lower edge to catch food. The medusa type of coelenterate is rarely found as fossil because it forms no skeleton. Living jellyfish have this form of body. The other body type is that of the polyp which is like a tube with one end closed and with a ring of tentacles around the edge of the other end. Coelenterates with a polyp form are mainly responsible for the coral reefs because they secrete a skeleton.

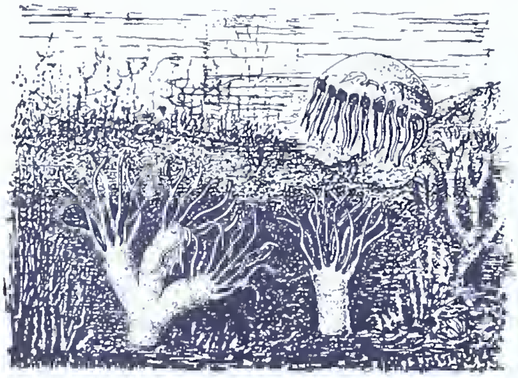


Fig. 9. Diagrammatic sea-bottom sketch showing a floating medusa and attached polyps.

Corals are characterized by the colonial mode of life, whereby many individuals join together to grow one large skeleton on which they all live. Some corals, however, are solitary and their skeletons are grown singly.

In Pennsylvania four groups of this phylum are found as fossils. All of these groups are extinct but because of the similarity in skeletal form to living coelenterates they are placed in the Phylum Coelenterata and reconstructions of what they must have looked like can be made.

Class Scyphozoa

This class of coelenterates includes the free-floating jellyfishes that have the body form of a medusa. However, there is one small group of

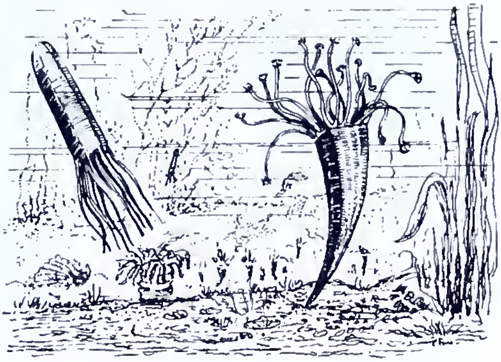


Fig. 10. Reconstructed Devonian sea-battam sketch showing ottached and floating canuloriids. (x ¼)

fossils called Conulariids that are placed in this group. Unlike the jellyfish some of these were attached to the sea bottom.

The fossil conulariids are generally cone shaped or pyramidal and consist of a thin flexible chitin outer "skin" that is usually marked with many lines that are curved or angular. Because some of these may have floated like a medusa and because of other similarities, this unusual group is placed in the Class Scyphozoa.

Conulariids have been found in Devonian shales in central and eastern Pennsylvania.

Class Hydrozoa

Hydrozoans include both colonial and solitary polyps and medusa-type individuals. They usually do not have any skeleton other than a

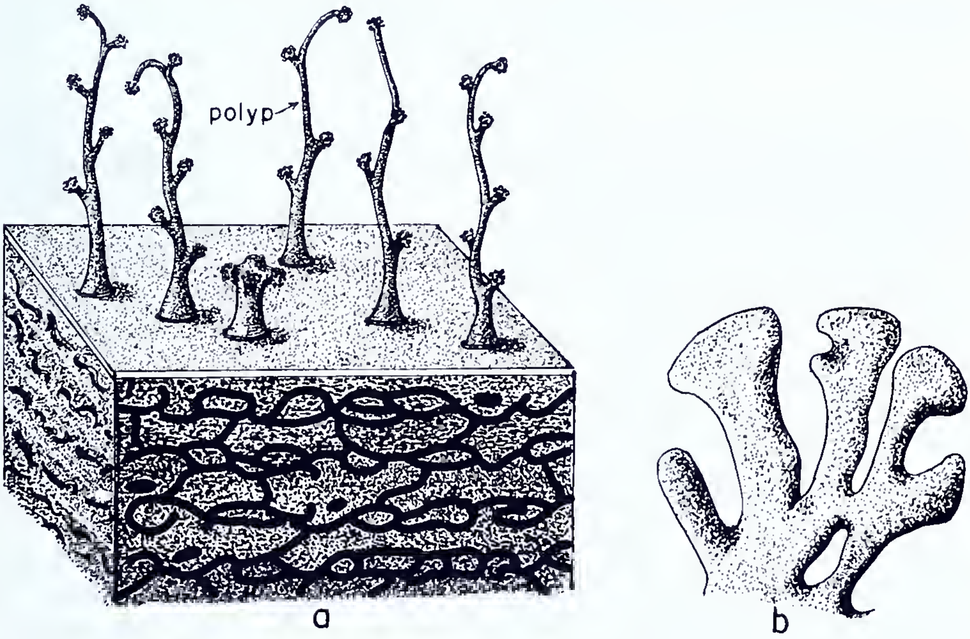


Fig. 11. *Millepora*—a living hydrozoan; a. diagrammatic sketch of surface part of a colony, the polyps live on the surface of the calcareaus skeletan. (x 40) b. portian of a branching colony of *Millepara*, the tiny dots are the palyps. (x 1)

chitinous covering. A few, however, form a calcareous skeleton that looks like a series of irregular porous layers one on the other. In the pores and on the upper surface of the skeleton live a large number of polyps, connected at their bases by living tissue.

An extinct group, the Stromatoporoidea, also built a skeleton much as the living hydrozoan *Millepora* does. The skeletons consist of ball-shaped, mound-shaped, or twig-shaped masses which, internally, are composed of many layers (lamellae) with pores and holes in them. Presumably their surface was covered with similar polyps as in *Millepora.*

Stromatoporoids were an important reef builder in the Silurian and Devonian Periods. They are often found in some of the lower Devonian and upper Silurian limestones of central Pennsylvania.

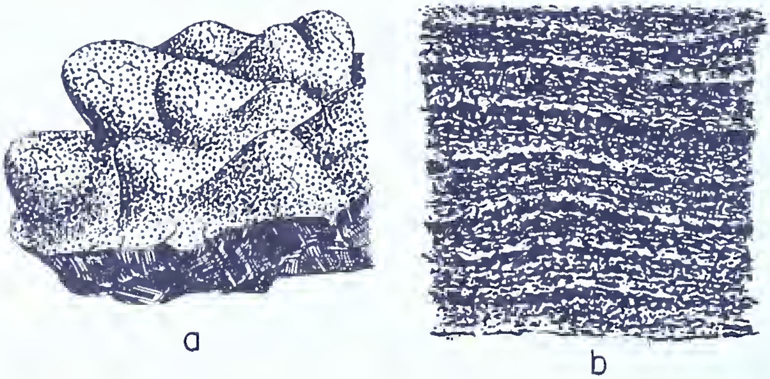


Fig. 12. *Stromatopora*—a fossil hydrozoan; a. part of a colony. (x 1½) b. section through colony showing layers (lamellae). (x 3)

Class Anthozoa

The anthozoans include most of the corals that build our modern reefs. Only the polyp form of individual is found in this class which is exemplified by the sea anemones.

Anthozoan polyps form a tubular, cup-shaped or horn-shaped skeleton that may be joined with others or be solitary. Each skeleton is called a *corallum.* The polyps live mainly in the cup-shaped depression at the upper or outer end of the corallite and rest on radial partitions (septa) that extend the length of the tube, or plates (tabulae) that extend across the tube. As the polyp adds more to the walls of the corallite, it also adds to the septa so that its soft body always remains near the outer end. In those forms with tabulae it periodically adds a new one so that the polyp is not too far down the tube. The polyp can retract itself into the tube in case of danger but it usually remains outside with its tentacles waving about in the sea water to catch food. (See Fig. 1.)

Within the Anthozoa are several groups, three of which produced most of the corals of the world. The corals of our present ocean belong

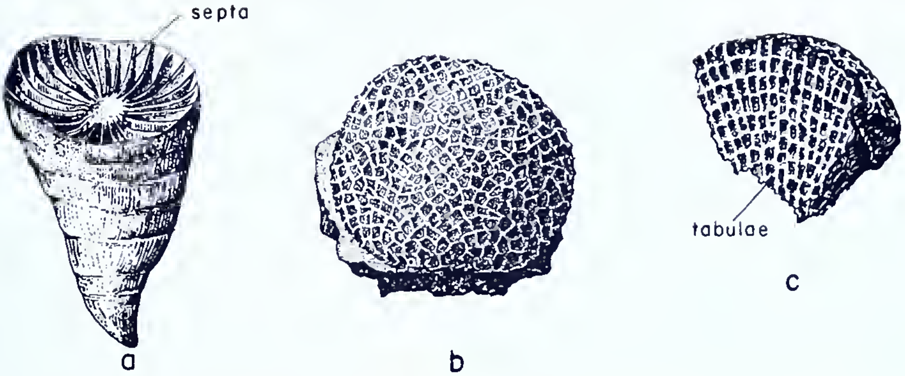


Figure 13. Anthozoan corals. (x 1); a. a solitary, rugose corallite, the radial partitions are the septa. b. a colonial, tabulate corallum, each hole housed a polyp. c. section through a tabulate corallum to show the transverse partitions, the tabulae.

to the Scleractinia. This class is also found as fossils back to Triassic times but not in the rocks of Pennsylvania. Pennsylvania corals belong to the Rugosa and Tabulata, two groups that are extinct. Both the Rugosa and Scleractinia have septa but they are arranged in different patterns that readily distinguish the groups.

The Rugosa built large massive colonial skeletons and horn-shaped solitary skeletons. The individual corallites are characterized by a rough and ridged outer surface. Rugose corals also contain septa. The Tabulata are colonial and are characterized by having tabulae without septa. A few genera have septa but in these the septa are usually very small.

Both rugose and tabulate corals are found in the Paleozoic rocks of Pennsylvania. They are relatively common in some of the Silurian and Devonian rocks of central and eastern Pennsylvania.

Phylum Bryozoa

The bryozoans are a group of exclusively colonial animals that live mainly in sea water. While some of them have built encrusting skeletons that contributed to reefs, most of them secreted delicate skeletons that

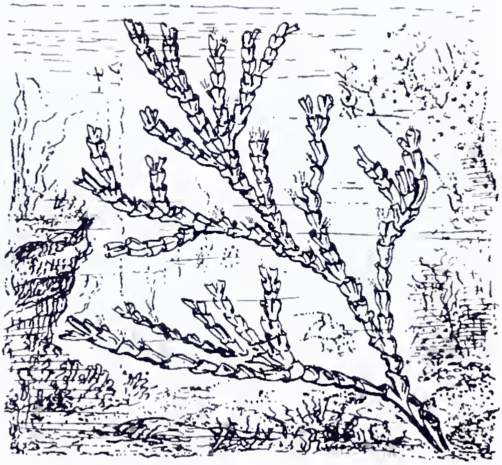


Fig. 14. *Bugula*, a living bryozoan. (x 1) Each of the small sections houses a zooid.

look much like plants, moss or sea weed. Many bryozoans build very thin, delicate, crust-like skeletons on stones and sea shells. Because of their delicacy, few are found complete. After death they are usually scattered about like broken twigs and branches of a tree.

Each individual bryozoa is extremely tiny, and the colonies they form usually have dimensions of about 1 inch. A hundred or more bryozoans may live in a colony that is an inch or two long. The soft body of the bryozoans is similar to the polyps of the coelenterates in that the body is tubular and has a ring of tentacles around its outer edge. However, this resemblance is only superficial because the bryozoan body, called the *zooid*, has much more complicated organs than does the relatively simple coelenterate polyp.

Each of the zooids secretes a long tubular skeleton that may or may not have various partitions similar to tabulae. Surrounding the tubes (called zooecia) is other skeletal material that binds them all together. A complete colony is called a *zoarium*. The soft body was capable, by complex muscles, to push itself out of its *zooecium* to collect food with its tentacles or to completely retract itself within its skeleton.

Many forms can be identified by their surface character, but positive identification of bryozoans frequently can be made only by microscopic examination of thin, transparent slices cut from the specimen.

Two of the forms of fossil bryozoans that you may find are the twig, branch or mound-shaped form that has zooecia all over its surface, and the ribbon or lacy form that has zooecia on one side or surface and often consists of several long branches connected by short bars so as to give it a lacy appearance. Fossil bryozoans all belong to the class Gymnolaemata.

Bryozoans are found in all the periods from the Ordovician to the present and in some localities make up a large part of the rock. They are found most often in limestones and shales throughout the Commonwealth.

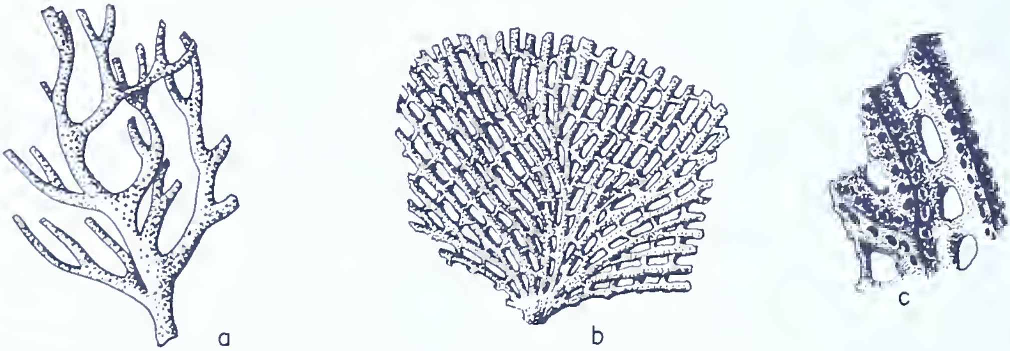
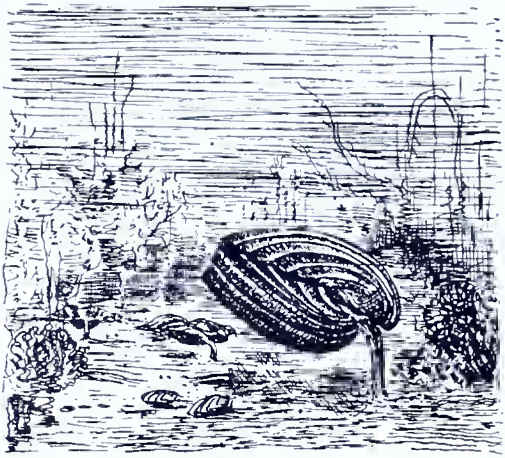


Fig. 15. Fossil bryozoa; a. *Batostomella*, a branching type. (x 25) b. *Fenestrellina*, a lacy type. (x 1) The black dots are zooecial apertures. c. part of b. expanded to show zooecial apertures. (x 15)

Fig. 16. Brachiopods on the sea floor.



Phylum Brachiopoda

Brachiopods are small marine animals that possess two shells (or valves as they are most commonly called) that completely enclose the soft body.

Only a few representatives of this once immense phylum are to be found in our present seas. Brachiopods flourished on the bottoms of Paleozoic seas and at times formed banks similar to the oyster banks of today. Brachiopods were animals that burrowed into or were attached to the sea bottom; they were not capable of moving about.

Because they bear many similarities, brachiopods may be confused with pelecypods (clams and oysters) which are also marine bivalves. Structurally, both the soft body and the enclosing valves of brachiopods differ very much from the pelecypods. The soft parts of pelecypods consist mainly of a large muscular "foot" for digging and moving about and a set of strong muscles that close the shell. Brachiopods consist mainly of a complicated feeding mechanism called the *lophophore* and specialized muscles that open and close the valves.

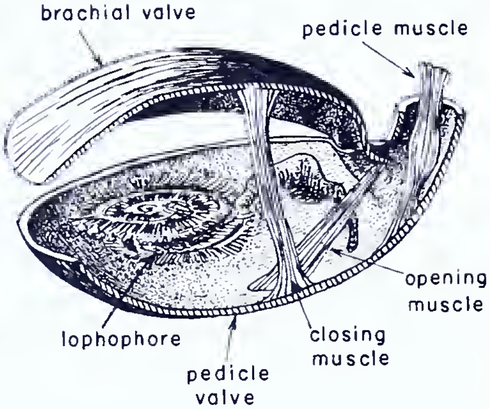


Fig. 17. Cut-away sketch of an articulate brachiopod showing the muscle system and the lophophore. Certain other organs are omitted from the sketch.

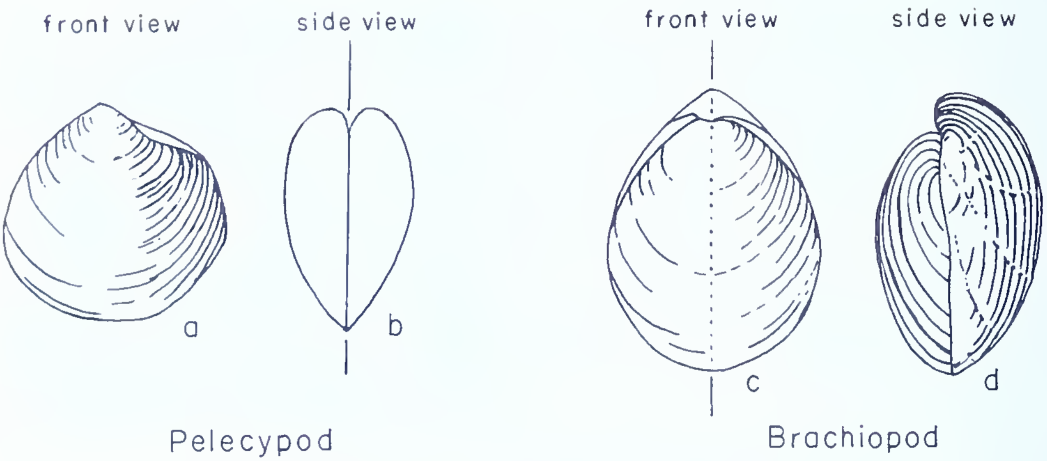


Fig. 18. Symmetry differences between pelecypods and brachiopods.

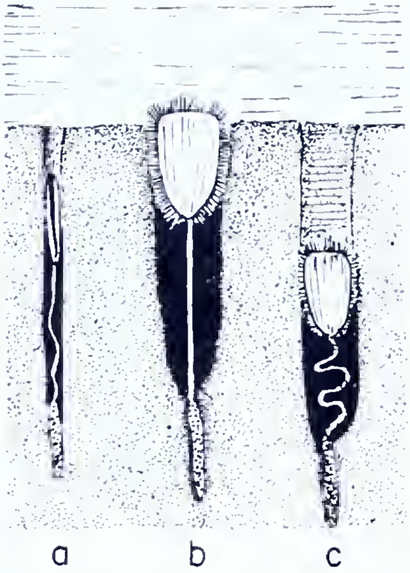
The valves of both these groups are also different. Brachiopods have valves that are bilaterally symmetrical but are unequal in size. In other words, the two brachiopod valves are of different sizes, but each may be divided into two symmetrical halves as in "c" of Figure 18. Pelecypod valves, however, are equal in size and are not bilaterally symmetrical ("a" of Figure 18). The two valves of a pelecypod look like each other, but each valve cannot be divided into equal halves.

The larger of the two brachiopod valves is called the pedicle valve because this valve bears the pedicle, a long muscular stalk which is used to attach the shell to the bottom. Not all brachiopods use this method of attachment. Some grow long spines all over the valve and rest on these. Others lie loose on the sea floor. Some even cement themselves to stones or to other animals. The smaller valve, the brachial valve, bears the brachia, the organ used in acquiring oxygen.

The phylum is divided into two classes, the Inarticulata and the Articulata, which are based on the way the two valves are joined together at the hinge. The hinge is at the rear and allows the valves to open and close without being completely separated.

The inarticulate brachiopods are characterized by the absence of teeth and sockets near the hinge line and possess only muscles to hold the two valves together. Their valves are usually composed of phosphatic and chitinous materials. *Lingula*, a modern inarticulate, lives along some sea shores and burrows deep into sand where it is attached by a very long pedicle. Fossil valves of the genus *Lingula* are also found in rocks as old as the Cambrian and thus provide one of the best examples of an animal that has ceased to evolve for over 500 million years.

Fig. 19. Schematic sketch of the burrowing life habits of *Lingula*, a living inarticulate brachiopod; a. side view to show narrowness of the brachiopod and its burrow. b. extended feeding position. c. retracted position. (x ¼)



The class Articulata is characterized by having teeth in the pedicle valve and sockets in the brachial valve. The articulate muscle system is less complex than that of the inarticulates because it is used only to open and close the valves. The majority of all known brachiopods are articulate.

Brachiopods were common during the Paleozoic Era but have declined in number since then. (See Figure 1.) Because of their abundance during the Paleozoic and because the various genera evolved and became extinct quickly, the brachiopods are useful in subdividing and identifying Paleozoic rocks over the whole world.

Articulate brachiopods, in a variety of shapes and sizes, are probably the most common fossil found in Pennsylvania. They are present in nearly all fossiliferous rocks in the Commonwealth.

Phylum Mollusca

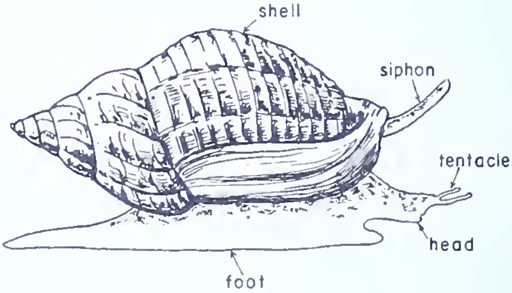
Phylum Mollusca includes a varied group of animals such as the well known slugs, snails, oysters, clams, squids, octopuses and others. Although differing greatly in size (from less than an inch to several feet) and shape, these animals are all closely allied. The phylum is divisible into seven classes, one of which is extinct. Of the seven classes, only four are important paleontologically. These are gastropods, cephalopods, pelecypods, and cricoconarids (extinct).

With certain modifications, the soft bodies of the animals in all classes of this phylum are similar. Five of the six living classes (the cephalopods excluded) contain animals with a muscular "foot" (Figure 20) which is used for moving and burrowing. In the cephalopods (squids and octopuses) this foot is modified into the tentacles near the head region. Five of the six living classes also have gill structures for breathing and have a well-defined head region with a mouth. The pelecypods ("clams") do not have a definable head. Soft parts of various molluscan animals can be shown to possess many more similarities than those mentioned above.

Class Gastropoda

Gastropods live throughout the world both on land and sea. Those which have no shells are the slugs; those that carry shells are snails. Those snails that live on land have developed lungs. The others have typical molluscan gills for living under water.

Fig. 20. Anatomical parts of a snail.



The individual gastropod consists mostly of the muscular foot on which it moves, a head with two tentacles, and a body upon which is carried a coiled, unchambered shell. In time of danger the snail withdraws its body into its shell. Some gastropods have evolved an *operculum* or door that covers the opening to their "house". Figure 20 shows the organs of a gastropod.

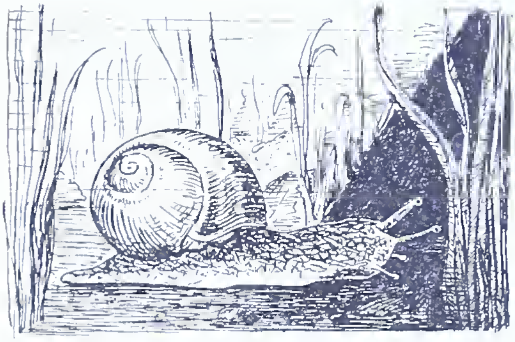
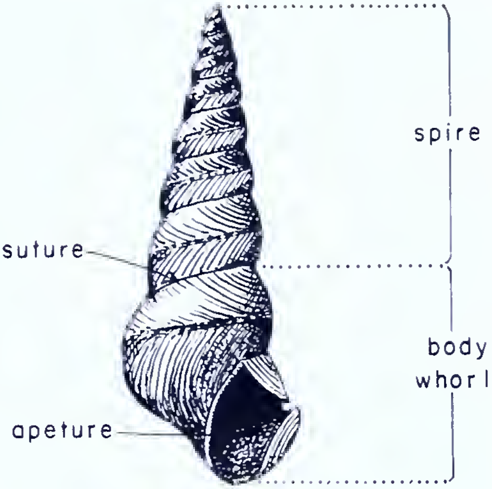


Fig. 21. A snail on the sea floor.

Starting with a simple coil, gastropods build many very different kinds of shells. Some have complex external structures and ornamentation; some are smooth. The snail shell is divided into two main parts: the *body whorl,* which is the last turn of the spiral and the *spire,* which are all the other spiral turns above or behind the body whorl. The opening is called the *aperture;* the line between the many whorls (turns of the spire) is called the *suture.*

After the snail dies, the shell often fills with mud. If, after fossilization, the shell disappears, an internal mold is left. These are called *steinkerns.*

Fig. 22. The parts of a snail shell.



Gastropods, like brachiopods, can be found in almost all of the fossiliferous rocks in Pennsylvania.

Class Pelecypoda

The pelecypods include some of the organisms we call shell fish—the clams, oysters, and scallops. These are an important food product of the sea. They differ from the other members of the mulluscan clan by their habit of secreting an external skeleton of two valves, as do the brachiopods.

Pelecypods are more varied in their home sites and methods of movement than are other groups of the Mollusca. The snails (gastropods) being non-swimmers usually dwell on a surface such as the sea, lake and stream bottoms. The cephalopods are largely made up of swimmers. Some

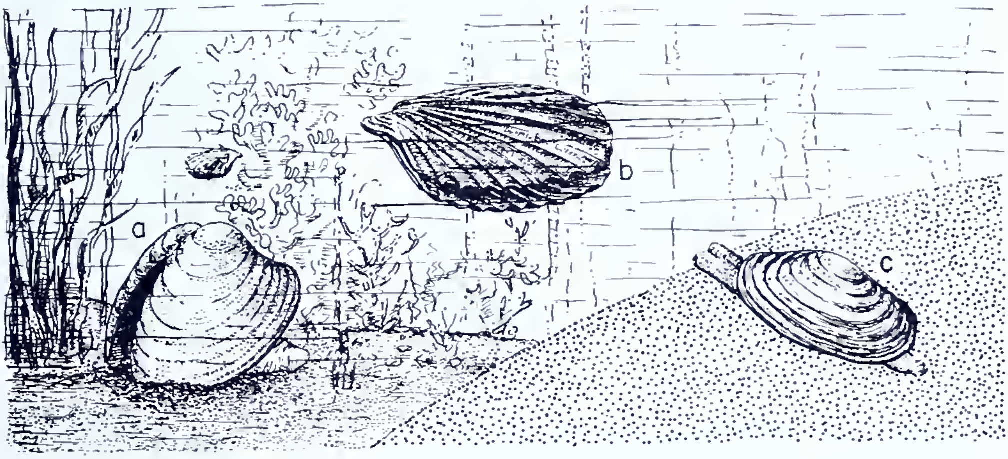


Fig. 23. Schematic sketch of the life habits of clams (pelecypods). (x ¼); a. *Venus*, a bottom dweller. b. *Pecten*, a swimmer. c. *Mactra*, a burrower.

pelecypods dwell on a surface and some swim about. The scallop *Pecten* swims about in the water by strong muscular movement of its valves. Many pelecypods live on the bottoms of bodies of water where they move by using their foot. They often bury themselves deeply into the mud. Some even bore into rock to find a hiding place. A few of the pelecypods, such as the oyster, cement themselves to the bottom. The oyster is one of those unusual pelecypods in which both valves are not the same size.

The two valves are called right and left valves because many of the pelecypods move about with the foot downward and the beak (the pointed part of the shell) upward. Thus the valves are the "sides" of the animal and are called left and right. Both valves have teeth and sockets along their hinge line to keep them attached. Fossils that preserve the interior often show the position of the large muscles that hold the valve closed.

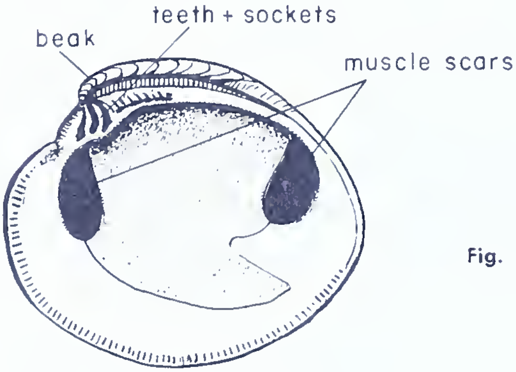


Fig. 24. View of the interior of a pelecypod right valve.

Pelecypods are a common fossil in some of the fossiliferous rocks of Pennsylvania but are found most often in the sandstones and shales of the middle and upper Devonian of central and northern Pennsylvania.

Class Cephalopoda

The class of mollusks called cephalopods, instead of having just an external shell, may have shells that are external or internal. Some, such as the modern octopus, have no shell. The cuttle fish *Sepia* has only a very small internal shell called the rostrum, often used in bird cages. Most fossil cephalopods possessed a rather intricate external shell.

Only one living representative of the external-shelled group is known. This is the pearly *Nautilus* that is found in our south seas. From this sole living member of a nearly extinct group, we know much about how many fossil cephalopods must have looked and how they lived.

Fossil cephalopods built many varied and intricate shells. The simplest type of shell is straight and shaped like a cone. Others have a small curve to the shell, and still others are completely coiled. The coiling

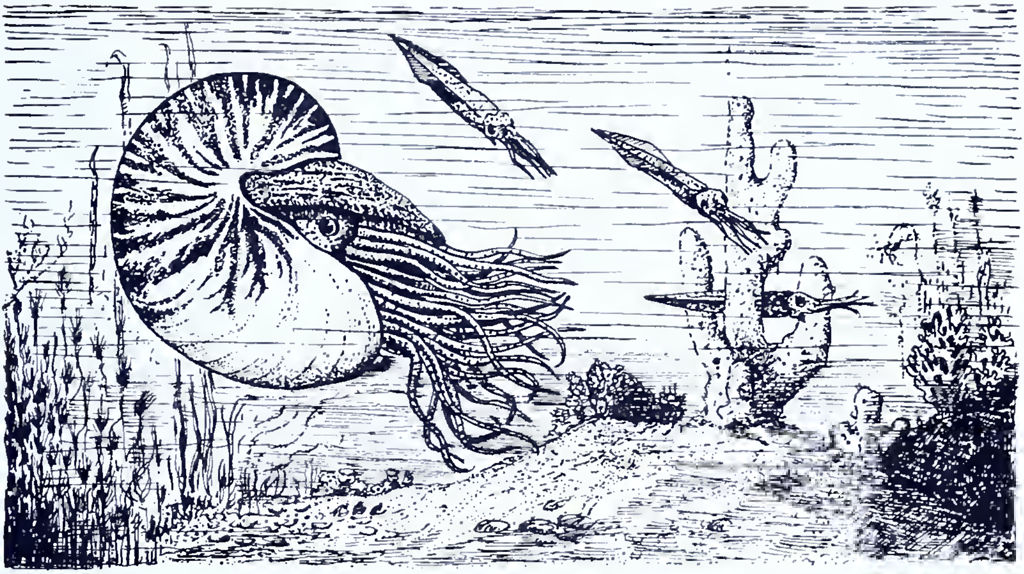


Fig. 25. The "Pearly" *Nautilus* and its relatives, the squids. (x ¼)

of the cephalopods was generally in one plane rather than spirally as in most snails. A few cephalopods, however, did build a spirally coiled shell.

A major difference between cephalopod shells and the somewhat similar snail shells is that cephalopods separated their shells into many chambers by creating partitions (septa) at intervals. The animal itself lived in

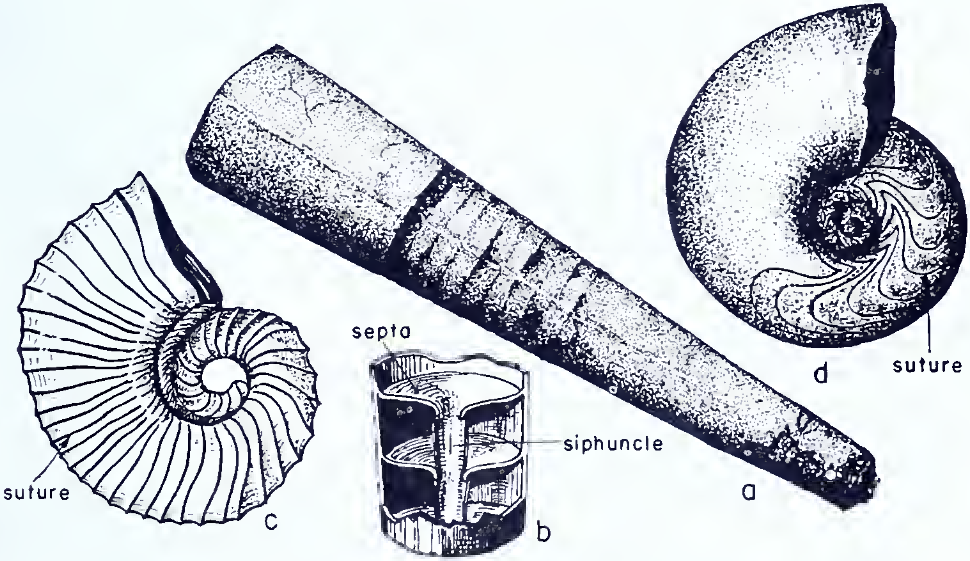


Fig. 26. Types of fossil cephalopod shells. (x ½); a. *Michelinoceras*, a simple, uncoiled shell. b. enlarged portion of a. showing interior partitions (septa) and the connecting tube (siphuncle). c. *Centroceras*, a coiled shell with even septa shown by the even suture. d. *Manticoceras*, a coiled shell with wavy septa, shown by the uneven suture.

the last chamber. The septa were perforated by a tube called the siphuncle through which a fleshy stalk was extended from the living chamber to the tip of the shell.

In a simple cephalopod each partition (septum) was much like a watch glass, a simple, smooth, concave partition. Where the septum is attached to the shell wall a line appears, called the suture line. More complex cephalopods built septa that were wavy along their edges, thus creating a more complicated suture line. The septal chambers were filled with gas during life so that the animal could float and swim in the water and yet carry around a strong, heavy shell that provided protection against its enemies.

The exterior of the shell was modified. Many had a smooth exterior; others had ridges along or around the cone. A few built spines along their shell. (See Fig. 1.)

Cephalopods are not too common in Pennsylvania. However, they may be found in many of the Devonian rocks of central Pennsylvania, particularly in the rocks of the Hamilton Group.

Class Cricoconarida

A few unusual fossils of extinct animals are placed in the class Cricoconarida of the phylum Mollusca because of some similarities they have to other living mollusks. Because they are extinct it is not known if they truly belong to this phylum. One of these extinct fossils in *Tentaculites* which is very small, cone-shaped, and needle-like, and is characterized by having several raised ring-like ridges around its surface. The shell was hollow in life with one end closed and the other open.

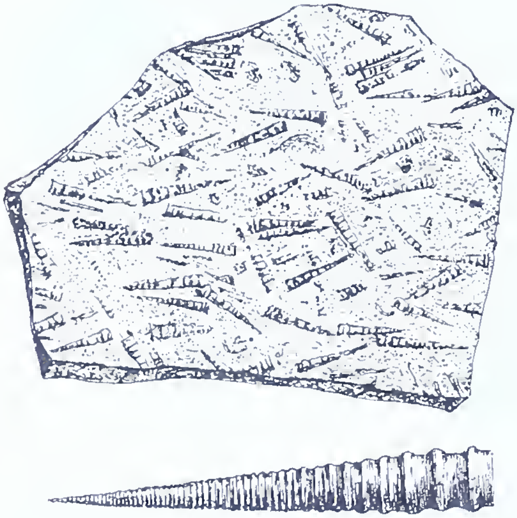


Fig. 27. *Tentaculites*—a cricoconarid; a rock with many individuals. (x 1) plus expanded sketch of an individual.

The type of animal that lived in this shell is unknown. A truly accurate idea of what it looked like in life is impossible to recreate because it differs from all other mollusks.

Tentaculites is a very common fossil in many of the Silurian and Devonian limestones of central Pennsylvania.

Phylum Annelida

The common earth worm *Lumbricus* and other similar worms are the animals included in the phylum Annelida. Annelids are characterized by the segmented nature of their body; the body is made up of many ring-like segments (annulae). These worms, since they generally secrete no hard parts, are rare as fossils. However, a few members of this group do have some preservable parts.

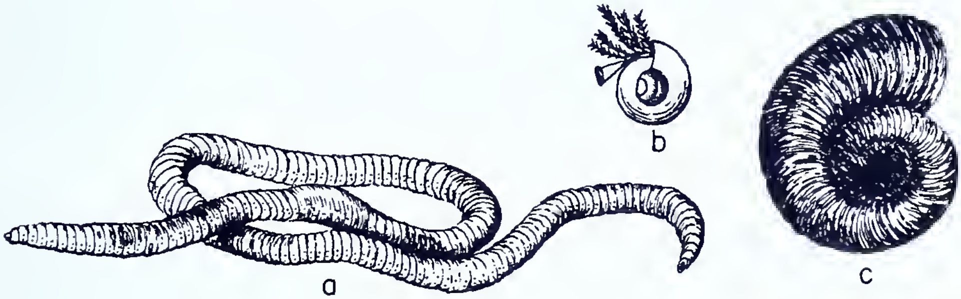


Fig. 28. Annelid worms: a. *Lumbricus*, the common earthworm. (x ¼). b. *Spirorbis*, a polychaete worm in its shell. (x 5). c. the shell of *Spirorbis*. (x 10)

A few annelids of the class Polychaeta form tubes of different substances. These tubes are built of organic material, fragments of sand, silt, or broken seashells, and calcium carbonate. The worm uses the tube as a protective covering and frequently also creates a door (operculum) to cover the opening. Some of the tubes are attached to the rocks and other shells on the sea bottom. Some types of worms carry the tube. Some worms even leave their "house" for a short time to feed and then return to it for protection. The living polychaete *Spirorbis* forms a coiled calcareous shell somewhat like a snail shell. This same tube may be found in rocks as old as the Ordovician and is an example of a genus that has evolved little in its long existence on the earth.

Some polychaete annelids have jaws (called scolecodonts) made of a chitinous-siliceous substance that is hard enough to be preserved in some rocks. Their jaws are microscopic in size.

Fossil annelids, primarily *Spirorbis* have been found in some limestones in western Pennsylvania. They are a rare fossil.

Phylum Arthropoda

The largest of all animal phyla is the phylum Arthropoda. About 75% of all living animals belong to this extremely varied group. The animals that are placed in the phyla are all characterized by a body that is divided into several segments (head, body, abdomen, tail and other segments) and is enclosed by a hard external covering (the exoskeleton).

The phylum is divided into several groups, some of which have little resemblance to each other. Only two of these groups are important as fossils in Pennsylvania. These are the extinct class Trilobita, and the class Crustacea which includes living lobsters, crabs, barnacles and ostracodes. Some of the other classes placed in this phylum are: the class Hexopoda (all the many types of insects); the class Myriopoda (centipedes and millipedes); the class Arachnida (spiders and scorpions) the class Merostomata ("king crabs").

All of these classes have produced fossils, but, because of the weakness of the exoskeleton in many of the groups and because many of them are land or air dwellers, their exoskeletons have not been abundantly preserved.

Class Trilobita

Although the trilobites are an extinct group of animals, the similarities of their exoskeleton to living arthropods are such that paleontologists can generally reconstruct these fossils as they must have looked in the past.

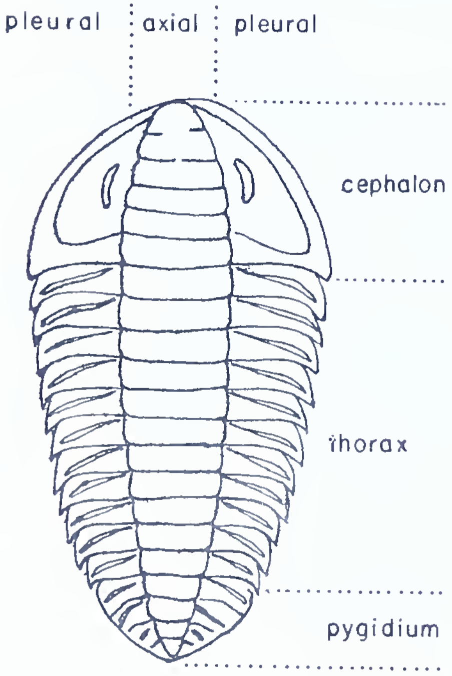


Fig. 29. Schematic sketch of a trilobite exoskeleton.

The trilobite body can be divided into three main regions, each of which is composed of smaller segments. These three regions are the head (cephalon), body (thorax) and tail (pygidium). In the cephalon and pygidium the smaller segments are fused together; in the thorax they are separate. Thus, when a trilobite dies, the exoskeleton is usually scattered about. Fossil hunters commonly find the head or tail complete but the thorax is rarely intact.

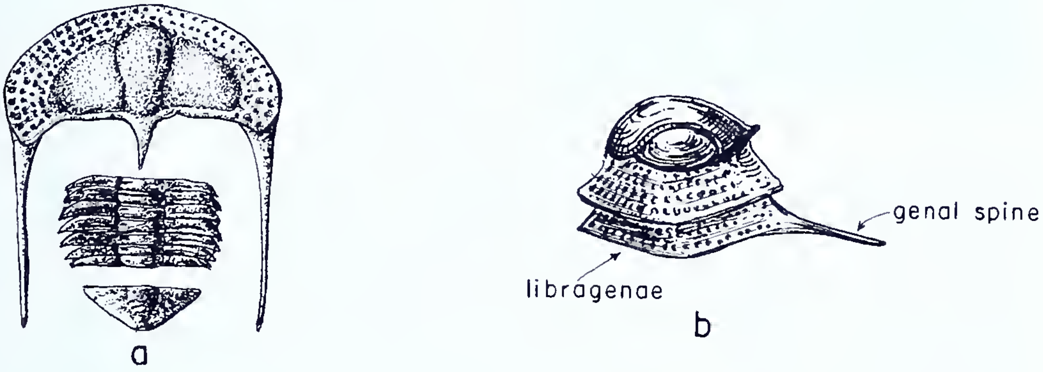


Fig. 30. ***Cryptolithus*—an Ordovician trilobite (x 4); a. the three major body divisions of *Cryptolithus*. b. side view of the cephalon showing the libragenae which fits underneath the cephalon. The genal spines are attached to the libragenae.**

Each of the three main regions is in turn divisible into three lobes by axial furrows that extend the length of the animal. The lobes are marked by indentations and consist of an axial and two pleural lobes; the axial lobe is usually higher than the others. In some genera, a small piece of exoskeleton called the libragenae (free cheek) is attached, but not fused, to the cephalon. Some trilobites also had a long spine at each side of the cephalon. These are the genal spines which are attached either to the free cheek or to the cephalon.

By comparison with living arthropods and by the study of a few fossil specimens with appendages preserved, paleontologists have determined that each segment in the three main regions had a set of legs or other appendages. In the cephalon the appendages were antennae.

Trilobites, as well as all other arthropods, shed their exoskeleton periodically as they grew. One trilobite, in its life time, produced many exoskeletons and it can be assumed that many of the fossil trilobites found are these discarded exoskeletons. These animals were probably dwellers of the sea bottom which crawled around in the mud in search of food as do living crabs. (See Fig. 1.)

Trilobites are a common fossil in many of the Cambrian, Ordovician and Devonian rocks of central Pennsylvania.

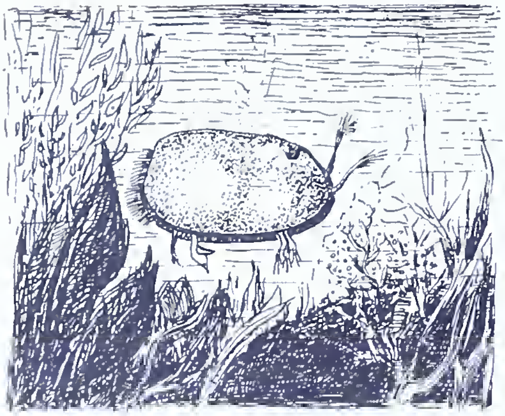


Fig. 31. ***Cypris*—A living ostracode in the swimming position, view of the right side. (x 20)**

Class Ostracoda

Ostracodes are extremely small organisms and one must use a magnifying lens or microscope to see them. Study of living ostracodes in our seas and rivers enables us to place them with the other crustaceans, such as the crabs and lobsters, although they look nothing like their relatives.

These small animals look more like a very small pea with a hard exoskeleton composed of two valves (somewhat like the brachiopods and clams) that encloses the soft body. Since their exoskeleton has no resemblance to other crustacean exoskeletons we must examine the soft parts of the ostracodes, specifically the legs, to determine their correct placement in a phylum. Because ostracodes have several sets of jointed legs and antennae just like crabs and lobsters, and because their internal organs are similar to other crustaceans we know that they are definitely a member of this group.

Ostracodes use their legs to swim about in the water and feed from sea weed and debris on the bottom. The legs retract and the valves close completely when the animal is in danger. The valves that cover the sides of the animal are called left and right valves because they swim in a vertical position with the legs hanging down between the valves.

Ostracodes have been found in many of the Silurian and Devonian limestones and shales of central Pennsylvania.

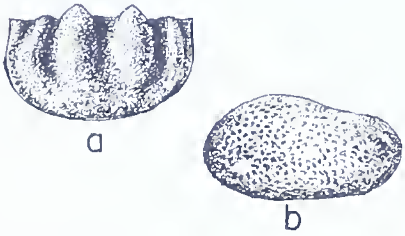


Fig. 32. Right volves of fossil ostrocodes; a. *Drepanellina.* (x 5); b. *Ponderodictyo.* (x 15)

Phylum Echinoderma

The Phylum Echinoderma is another group of animals that contains several familiar and unfamiliar classes which do not look much like each other. The common members of this phylum found along the sea shore are the star fishes (class Stelleroidea), sea urchins, heart urchins and sand dollars (class Echinoidea). Members not so well known are the sea "cucumber" (class Holothuroidea) and the sea lilies (class Crinoidea). The phylum also includes some extinct classes.

Fossil representatives of the living stelleroid, echinoid and crinoid classes and the extinct cystoid class have been found in Pennsylvania but, except for the crinoids, they are rare.

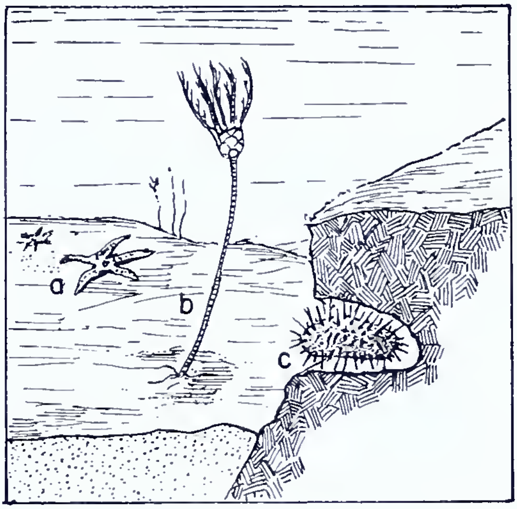


Fig. 33. Schematic sketch of echinoderms in their living positions; a. stelleroid (starfish). b. crinoid. c. echinoid (sea urchin).

Class Cystoidea

The cystoids are an extinct primitive class of echinoderms that bear close resemblance to the crinoids. They are divisible into two main parts—the stem (column) by which the animal attached itself to the sea bottom, and the body (calyx) made up of numerous irregularly arranged plates which enclosed the soft fleshy part of the animal. Some of the cystoids have small slender appendages (brachioles) which are similar to the jointed arms (ambulacra) of the crinoids. Some cystoids apparently have no brachioles. Crinoids differ from the cystoids in that the crinoid calyx contains a limited number of regularly arranged plates rather than numerous irregularly arranged plates. Crinoid ambulacra are much more complex than are the brachioles of cystoids. Cystoid plates are easily differentiated from crinoid plates because they bear a series of slits or pores through which fluids passed. Crinoid plates are solid.

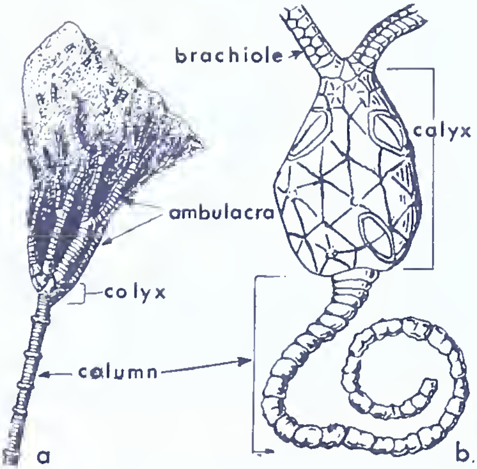


Fig. 34. Ordovician echinoderms illustrating the various parts. a. *Cupulocrinus* (crinoid). (x 1); b. *Pleurocystites* (cystoid). (x 1)

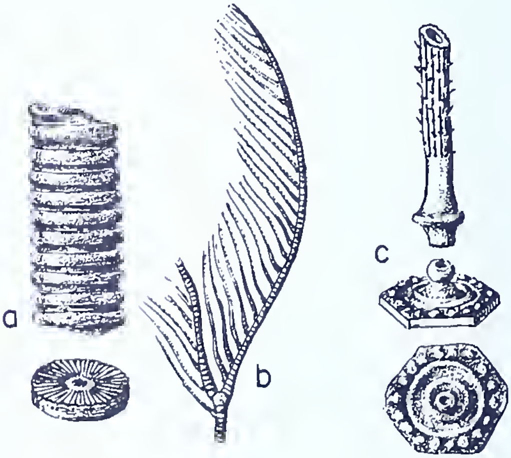


Fig. 35. Fragments of echinoderms; (x 2) a. portion of a crinoid column, one segment tilted to show grooved surface. Many have star shaped centers. b. a portion of crinoid ambulacra with attached pinnules. c. echinoid plate (lower figure), tilted plate (middle) shows ball upon which the spine (upper) fits.

Class Crinoidea

Crinoids bear resemblance to plants in that most of them have a stalk or stem that attaches the flower-like body of the crinoid to the sea floor. This stalk is called the *column* and is composed of many small segments that are jointed and allow the stalk to be flexible. The soft body of the animal is enclosed in an exoskeleton called the *calyx.* The calyx is composed of many regularly arranged plates of calcium carbonate held together by skin-like tissue. Many jointed arms (ambulacra) extend from the upper edge of the calyx. These wave about in the sea water and catch the food. Extending from the arms, in some species of crinoids, are various slender *pinnules.* These also aid in food catching by entrapping food particles in the mesh formed by the many pinnules.

Because the animal is composed of so many pieces it is rare to find whole animals. Pieces and parts of the column are commonly found; in fact, this is perhaps the most common fossil of Pennsylvania. Pieces of the calyx and arms are rare but have been found in some rocks. Occasionally whole calices with arms may be found.

Crinoid columns are common in almost all sedimentary rocks in Pennsylvania. Parts of the calyx and arms have been found in some localities, notably in the Greenbrier limestone of western Pennsylvania.

Class Stelleroidea

The common star fish of the sea shore is composed of many small calcium carbonate plates called *ossicles* that are loosely joined and covered by a leathery, muscular skin that holds the skeleton together. While these animals do not look much like the crinoids and echinoids, their organ systems, such as the digestive system, are similar, and on this basis these dissimilar classes are grouped together.

Star fish are dwellers of the sea bottom who move about by means of suckers or tube feet which extend from the underside of the arms. These animals are strong and with their suckers can pull apart clam shells to devour the clam.

Star fish are rare fossils because the skeleton is so loosely held together. However, complete molds of star fish have been found at the Swatara Gap in the upper Ordovician (Martinsburg) rocks of Lebanon County.

Class Echinoidea

Echinoids are sea-bottom dwellers that can move about somewhat, although not as well as the star fish. The spiny sea urchin uses the many spines on its surface to move about and also to hold itself fast in rocky places when the waves and currents are strong.

Sea urchins have a semi-globular shaped body composed of many ossicles held together by skin. In some species these ossicles are fused together and form a strong hollow skeleton in which the soft body is housed. The surface of the urchin is studded with many movable spines. In the days when slates were a schoolboy's common companion, some of the pencils used to write on the slate were the long spines of the sea urchin. The base of the spine had a socket that fit on a ball joint on the surface of an ossicle of the sea urchin. (See Fig. 35-c.)

Fossils sea urchins are rare because the skeleton usually falls apart after death. However, spines and some of the ossicles have been found in Mississippian and Pennsylvanian marine limestones of western Pennsylvania.

Phylum Chordata

The members of the chordate phylum are characterized in part by the presence of a *notochord* in one form or another. The notochord is a cartilaginous rod that provides support to the body of a chordate; it acts as a "backbone". In the vertebrates this chord is modified into a bony vertebral column made up of several individual vertebrae.

Many familiar animals belong to this phylum—man, whales, dogs, cats, elephants, birds and fish. It is a large and varied phylum. Also included within this phylum are some unusual animals that have relationship to their "vertebrate" cousins. One of these unusual groups is the class Pterobranchia, which are tiny colonial organisms that build a branching, chitinous, tubular exoskeleton. They look vaguely like some living bryozoa. However, they possess a notochord and thus belong to the chordates. This unusual class is important because of the similarities it has to an extinct group of animals called graptolites whose placement in a phylum has been a problem for many years because of the lack of living members to be used for purposes of comparison.

While many of the other chordate classes are important because of their fossils only the graptolites and the various classes of fish are commonly found as fossils in Pennsylvania.

Class Graptolithina

The extinct graptolites built a chitinous, colonial exoskeleton. Nothing is known of the soft body but they may have been similar to the living pterobranches. Each animal lived in a small cup (theca) on the side of a branch (rhabdosome) which looks much like a small saw blade with teeth on one or both sides. Each "tooth" is a theca.

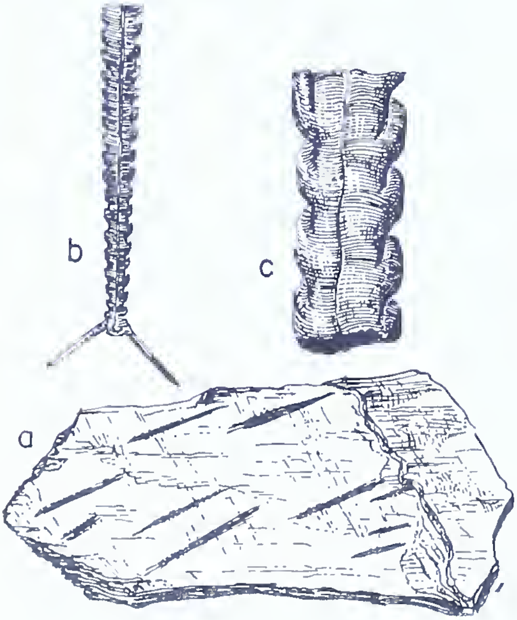


Fig. 36. *Climacograptus*—Ordavician graptolite; a. rhabdosomes on a rock surface. (x 1) b. a single rhabdosome enlarged. c. enlargement of part of the rhabdosame to show theca, the hales in which the individuals lived.

In life the rhabdosome was round and hollow and each individual was connected to another by fleshy material. The rhabdosomes are flattened in most rocks because they were crushed by the weight of the sediment which settled over them after burial. Graptolite rhabdosomes have many shapes and, as suggested in the reconstruction of a colony in Figure 37, were joined into a "super" colony that floated on the surface of the sea.

The Ordovician shales of central and southeastern Pennsylvania are the rocks in which graptolites are commonly found.

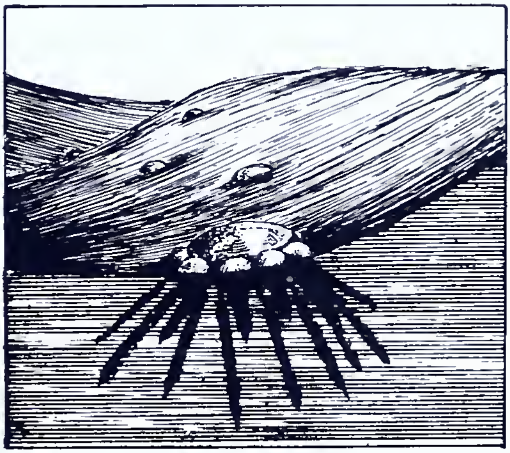


Fig. 37. A hypothetical reconstruction of a large graptolite colony which may have floated on the seas much as do living jellyfish.

Class Agnatha

Living agnathids have a fish-like body and include the parasitic lamprey, the scourge of the Great Lakes. The class is characterized by the lack of fins and jaws. The earliest known vertebrates belong to this class and are fish-like animals called ostracoderms (means armored skin) because their upper surface was covered with bony plates. They, too, possessed no jaws.

No complete specimens of agnathids have been found in Pennsylvania but one Silurian Period locality in Perry County is famous as a source for broken pieces of the dermal armor that covered this fish.

It is probable that they were a fresh water fish and lived on stream and lake bottoms. Some may have lived along the sea shores or along streams which emptied into the sea. The pieces of bony armor are characterized by a surface pattern much like a finger print pattern.

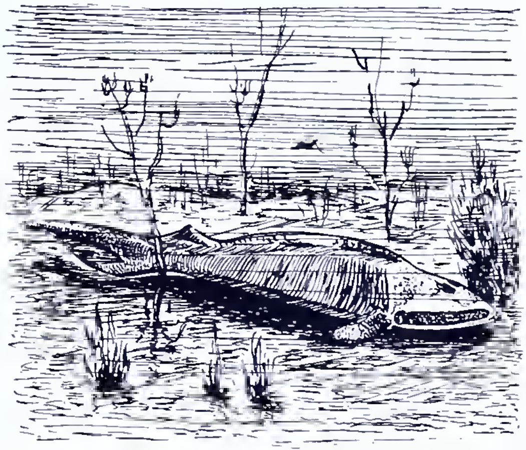


Fig. 38. *Hemicyclospis*—a Silurian-Devonian ostracoderm. (x ⅓) This primitive fish lived mainly on the food it obtained from sifting the bottom muds.

Class Placoderma

This class of extinct fishes differs from the Agnatha because its members possess jaws and have definite fins. The placoderms were an armored type of fish and the fossil remains of this group usually consist of broken dermal plates. Complete specimens are very rare. A reconstruction of *Pterichthyodes*, a Devonian placoderm is shown in Figure 1.

The Upper Devonian rocks of central and northern Pennsylvania are known for the fragments of dermal armor of these fish.

Class Chondricthyes

The living sharks, skates, and rays belong to this class of fish and are characterized by the absence of a bony skeleton. The skeleton of this class of animals is made up of cartilage. Because of the absence of a resistant skeleton, few complete remains have been found of the fossil sharks and their allies. However, teeth of these fish are resistant and are found in abundance in some areas.

Fossil shark teeth from Pennsylvania are of two general types. One is from the type of shark that inhabited marine waters and lived on a diet of mollusks (the bradyodonts). The teeth have a flattened surface to produce a crushing rather than biting action. These have been called "pavement" teeth.

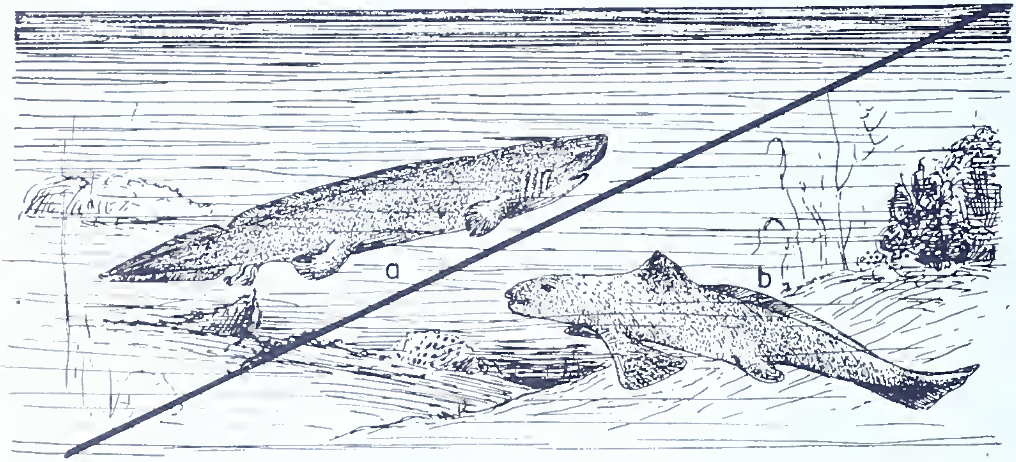


Fig. 39. Primitive late Paleozoic sharks. On the left *Pleuracanthus*, a fresh water pleuracanth about 2½′ long; on the right *Helodus*, a marine water bradyodont about 14″ long.

A group of sharks called pleurocanths that are unusual because they lived in fresh water rather than marine, have a tooth composed of two slender prongs.

These two types of shark teeth have been found in marine and fresh water limestones of Pennsylvanian and Permian age in western Pennsylvania.

Class Osteichthyes

This class includes those fish with which we are most familiar such as trout, perch and salmon. All of these have bony skeletons. Older members of this class, a group called the paleoniscoids, had well-developed bony scales and teeth. These fish, which were about the size of our herring and minnows, lived in fresh water. Another ancient group, the Choanichthyes, includes fish with many bony scales. Some of these fish were very large. They lived in fresh waters near to a shore. Choanate scales are found in many of our late Devonian Period rocks. Paleoniscoid teeth and scales have been found in some of the Permian fresh-water limestone of western Pennsylvania.

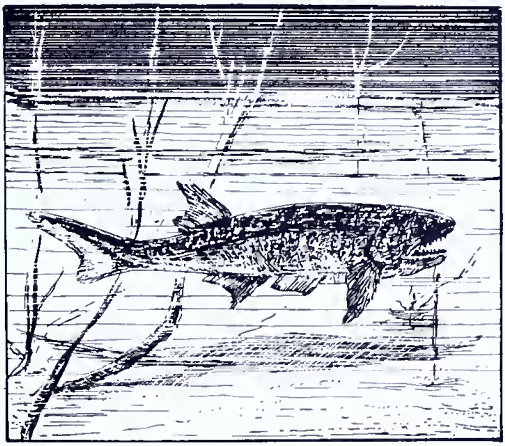


Fig. 40. *Cheirolepis,* a primitive bony fish from the Permian Period. (x ¼)

Class Reptilia

The ancient and extinct dinosaurs are members of the class Reptilia. Fossil specimens of the dinosaurs are extremely rare because these were animals that lived almost exclusively on land. It was only on very rare occasions that a dinosaur died and was buried before its bones decayed. The dinosaurs, however, did at times leave their footprints in the sand and mud that bordered the streams from which they drank. Fossil footprints of this type have been discovered in the rocks exposed in Adams County that were deposited during the Triassic Period. From these tracks and additional data it is possible to reconstruct the dinosaur that roamed over Pennsylvania. This dinosaur was small and was an ancestor of some of the larger plant-eating dinosaurs discovered in other parts of the United States. Although the dinosaur is shown in Figure 41 as a plant eater, this animal was also carnivorous.

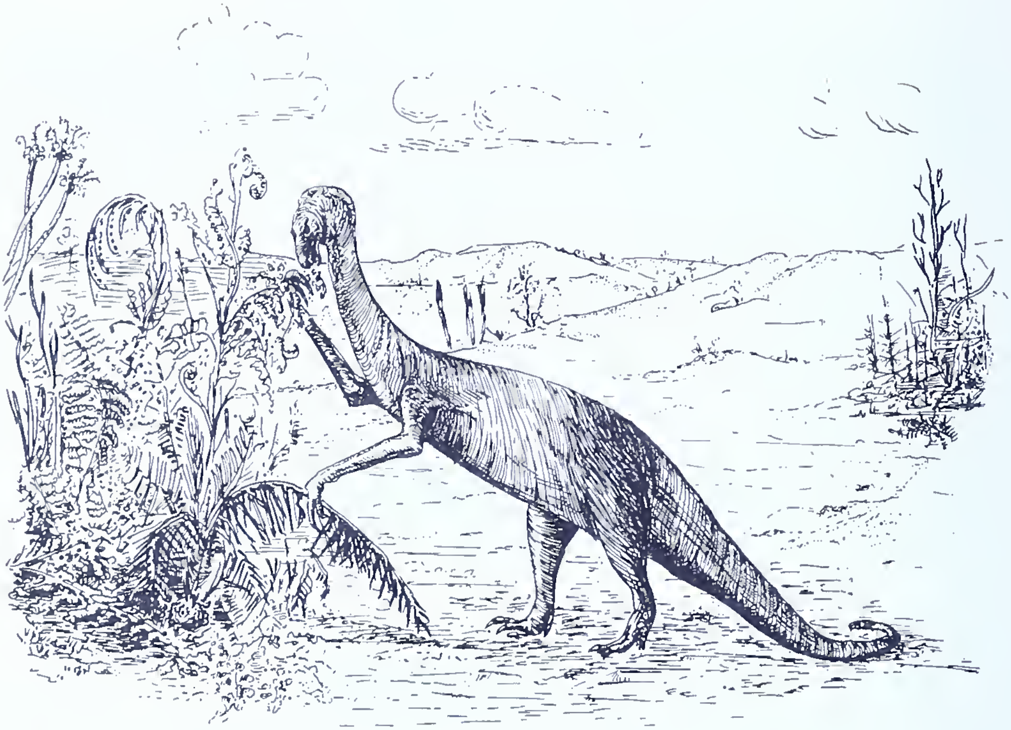


Fig. 41. A Triassic dinosaur—*Anchisaurus*—this animal was probably about 6-7 feet in height.

KINGDOM PLANTAE

The plant kingdom may be divided into four main divisions: Algae, Fungi, Bryophyta (mosses) and Tracheophyta (vascular plants). The first three of these divisions are relatively unimportant as fossils because they are seldom preserved. Some groups of the algae build a calcareous mat on the sea bottom and contribute to the formation of limestones.

The tracheophytes include the many types of fossil and living organisms we most commonly call plants. Of this division many plant fossils of the Pennsylvanian coal-forming swamps belong to one of the following groups: Lycopsida (fossil scale and seal trees, living club mosses), Sphenopsida (living and fossil horsetail rushes), Pteropsida (living or fossil ferns and seed plants).

Plants, because they generally are land dwellers, are not a common fossil throughout geologic time. For plants to become fossils, special situations which cause them to be buried rapidly must exist. Otherwise the plants decay and merely enrich the soil.

Pennsylvania is fortunate in having large amounts of fossil plants preserved in the coal-bearing rocks. These rocks were formed during a period of time when the unusual requirements for plant preservation were present. This was the period called the Pennsylvanian, so named because of the important coal beds found in the state. During the Pennsylvanian Period, large areas of the Commonwealth were covered with large and small swamps in which grew many types of trees, tree-like plants, ferns and fern-like plants. As the plants died they sank below the water surface where decay was slowed sufficiently that they could be covered by sediment before they were destroyed.

As with animals, plants break apart after death and become scattered. The leaves, fruit, branches, trunks or stems and roots of a plant may be completely separated from each other and, if they are buried and preserved, it may be nearly impossible to tell what pieces fit together. This is in a large part due to the great size of some fossil plants and the fact that fossils that are recoverable are usually ones that are hand-size rather than tree-size, so that a complete plant is very rare.

Scientists who study fossil plants (the paleobotanists) apply general and specific names to many of these separated parts of plants in order to be able to discuss them, realizing that they apply more than one name to the same real genus and species. These are called "form" genera so as to separate them from real genera. As work progresses in paleobotany, plants are pieced together, but the old names are retained for the sake of convenience. Thus the leaves, stems and fruit of the same actual genus and species may bear different names.

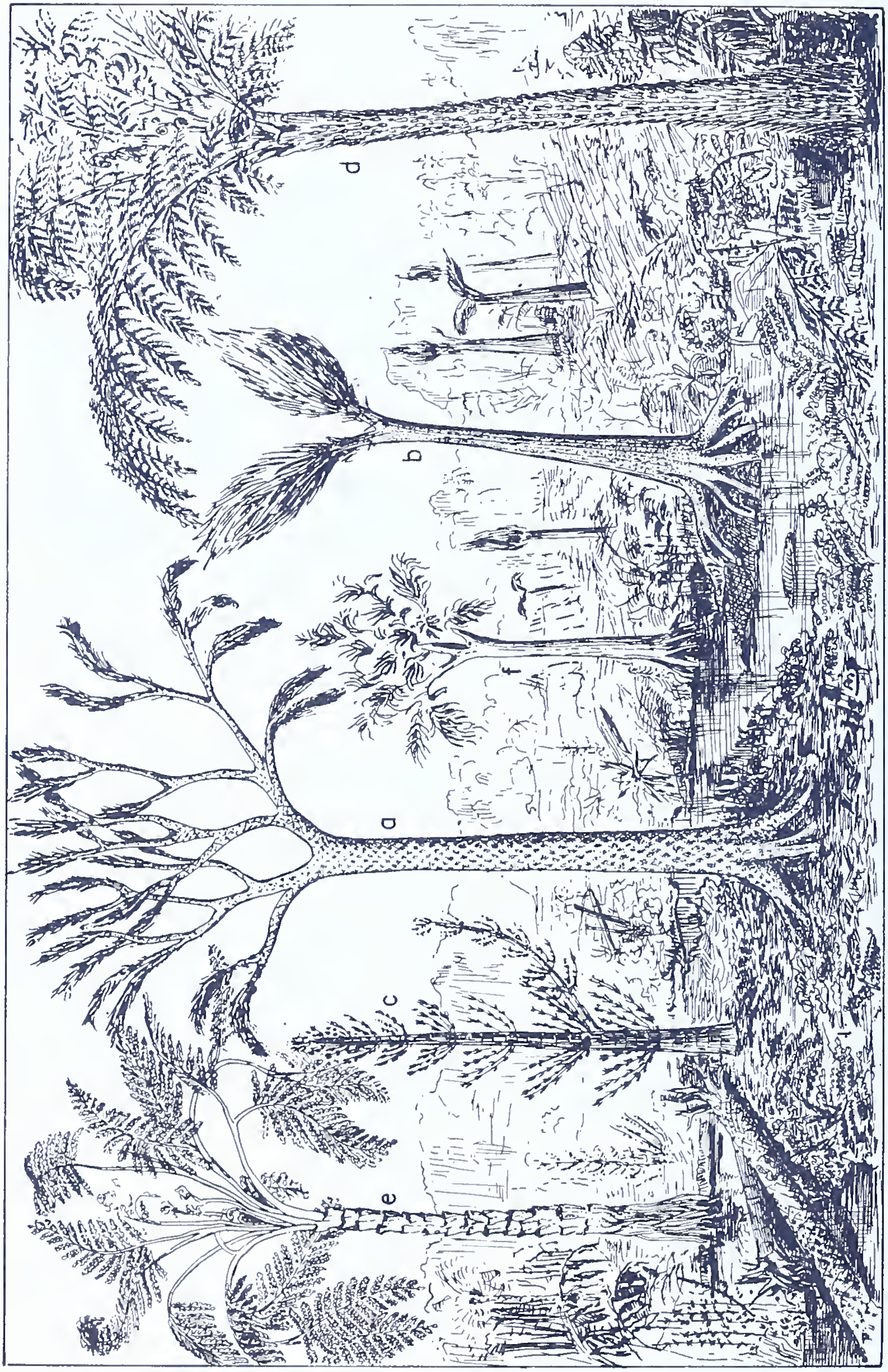
Lycopsida

Living lycopsids are the club mosses and ground pines that are used for decoration at Christmas time. They are a low, creeping, many-branched, evergreen plant that produces spores.

Fossil lycopsids were tree-like in form and thus look little like living members of the group. The two most famous lycopsids are the scale and seal trees—*Lepidodendron* and *Sigillaria*. Portions of their trunks are commonly found associated with the coal deposits. The leaves that covered the trunk left small scars after they fell off making the trunks appear scaly. In *Lepidodendron* the scars are arranged spirally; on *Sigillaria* the scars are in vertical rows and are more elaborate, having the appearance of a fancy seal or stamp.

Sphenopsida

The living horsetail rushes, so called from the similarity of their leaves to a horsetail, are the sole survivors of this class. They are sometimes called scouring rushes because they were used for polishing wood and metal in years past. They have a single, branching, hollow stem divided into sections by prominent joints. Living horsetails belong to the genus *Equisetum* and are small in size.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Fossil rushes belong to the genus *Calamites* which grew to heights of over forty feet. These tree-like plants were hollow-stemmed with conspicuous joints from which grew the leaf whorls which are called *Annularia*.

A small rush that grew beside the giant *Calamites* in the Pennsylvanian swamps, and belonged to the same class, is *Sphenophyllum*. This name is applied to both the stem and leaf whorls. *Sphenophyllum* is characterized by triangular or wedge-shaped leaves of the leaf whorl.

Pteropsida

This is the group that contains most of our living plants ranging in character from the tree ferns, seed ferns, cycads, and conifers to flowering plants. The tree ferns are called filicales and range from the small ferns of northern forests to giant ferns of the tropics. Tree ferns produce spores which are found in clusters on the underside or margin of the leaves.

Fossil ferns of the Pennsylvanian forests and swamps were of many sizes ranging up to tree-like ferns over thirty feet in height. The various parts of the fern plant were usually separated after death. Most often found are the fern leaflets of which there are several form genera.

Seed ferns belong to the Gymnospermae. Seed ferns are a group of extinct plants that were very prominent during the Pennsylvanian (more so than tree ferns) and were characterized by their habit of producing seeds rather than spores. They had fern-like leaves and were fern-like in their growth, producing large trees, climbing vines and other forms. The seed ferns were more complicated plants than tree ferns.

Another group of gymnosperms (cordaites), together with the seed ferns, made up the majority of seed plants in the Pennsylvanian. The cordaitean trees grew to over 100 feet tall and were important contributors to the making of coal. The tree top bore masses of large, spirally arranged, strap-like leaves that grew up to three feet in length and two to three inches in width. The cordaitean leaves are a fairly common fossil.

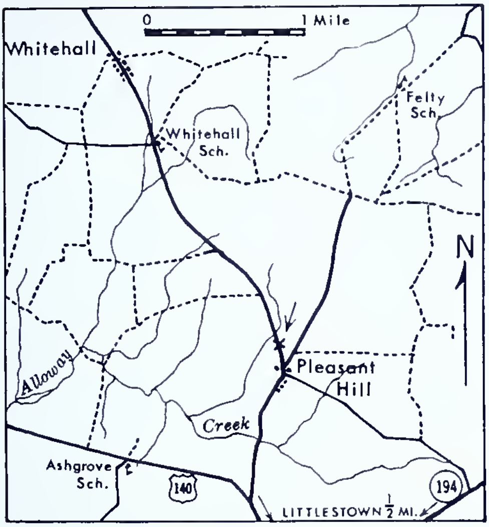
A few other fossil gymnosperms, belonging to the cycad, ginko and conifer groups, have been found in Triassic rocks in some areas of Pennsylvania but they are in general a rare fossil.

Fig. 42. A hypothetical reconstruction of a Pennsylvanian Period coal-forming swamp.

a. *Lepidodendran*, the "scale tree".
b. *Sigillaria*, the "seal tree".
c. *Calamites*, a rush.
d. *Psaranius*, a true fern.
e. *Medullasa*, a seed fern.
f. *Cardaites*, forerunner of the conifers.

COLLECTING LOCALITIES

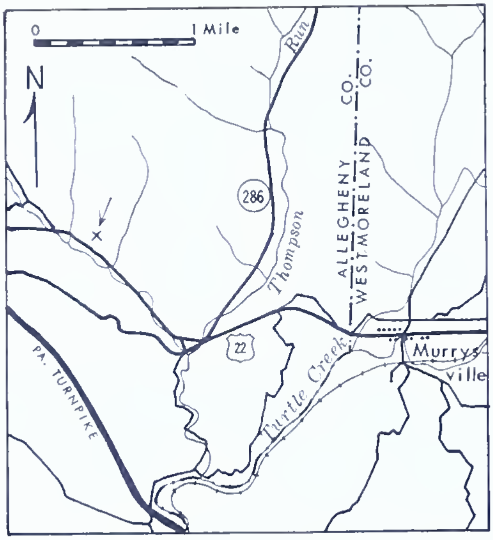
An attempt was made to include in this book at least one collecting locality for each of Pennsylvania's 67 counties. No suitable localities could be found for Chester, Delaware, Montgomery or Philadelphia Counties. The rocks of Philadelphia and Delaware Counties are not known to contain fossils. Fossil plants, vertebrate remains and a few other rare fossils have been reported from the Triassic Period rocks of Chester and Montgomery Counties but no suitable locality is known at this time that could be included in this book. Future editions will include localities for these counties providing suitable fossil collecting localities are discovered.



LOCATION. Except for the famous discovery of dinosaur footprints near Pondtown Mill, Adams County is nearly barren of significant fossils. The footprints now are in several museums. A few fossils may be found, however, in a small road cut along the township road 0.1 mile north of Pleasant Hill which is 0.8 mile north of the intersection of the township road and U. S. Route 140 at Littlestown. Fossils may be found in the yellowish shales that occur on both sides of the road.

FOSSILS. Only one definite fossil has been found at this locality. It is called *Pseudoestheria* (Plate 10). The fossil remnants of *Pseudoestheria* consists of small (¼ inch) "shells" of dark chitinous material characterized by curved lines on their surfaces that parallel the outline of the "shell". Impressions or external molds of the "shells" are also present. These "shells" look much like small clams but they belong to the Class Crustacea and thus are related to crabs, shrimps and lobsters. *Pseudoestheria* belongs to the Crustacean group called Conchostraca. Living members of the Conchostraca have a body made up of many segments, each with its own set of legs, and covered by a chitinous carapace nearly identical to the "shell" of *Pseudoestheria.* The "shell", more properly called the carapace, has two parts that fit together on either side of the soft body of the animal. It opens and closes for feeding, moving and protection. Conchostracans are similar to Ostracodes. Both are Crustaceans, are small, have several sets of legs, and are enclosed in a two part "shell". Ostracodes, however, generally have only calcareous carapaces, are very tiny (generally less than 1/16 inch) and differ considerably in details of the soft body. The sandstones at this locality also contain oddly shaped impressions or molds of unknown origin. These may be made from plants or fragments of trees.

GEOLOGY. The rocks at this locality belong to the Brunswick Formation and were deposited during the Triassic Period about 200 million years ago. The exposure is made up of yellowish shales and brownish sandstones that were deposited on land by a river or stream. The presence of *Pseudoestheria,* whose living relatives live only in fresh water, indicates that the rock was deposited in fresh water. The dinosaur footprints in similar rocks elsewhere in the county also indicate deposition of these Triassic rocks in fresh water lake, stream and river beds rather than in a large body of marine water such as a sea.



LOCATION. The very fossiliferous Ames Limestone of Pennsylvanian age is well exposed in a relatively new road cut on the north side of U. S. Route 22, 2.3 miles west of Murraysville. The exposure is 0.9 mile east of the Pittsburgh Exit (to U. S. 22) of the Pennsylvania Turnpike. The limestone outcrops in the road bank about 15 feet above road level for a distance of 200 to 300 feet. Many blocks of the limestone have fallen to a lower bench 3 to 4 feet above road level where they are easily accessible for collecting.

FOSSILS. The Ames Limestone is exceedingly fossiliferous at this locality. Many thousands of individuals of the brachiopods *Crurithyris* and *Chonetes* make up much of the rock. Many other well preserved and loose specimens may be found here also. Genera of fossils found at this locality are listed below and are shown on Plates 8 and 9.

BRACHIOPODS
- *Chonetes*
- *Composita*
- *Crurithyris*
- *Derbya*
- *Hustedia*
- *Linoproductus*
- *Rhipidomella*
- *Wellerella*

COELENTERATE
- *Lophophyllidium*

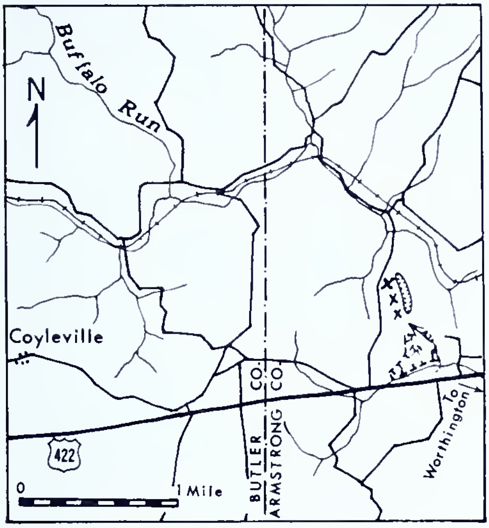
GASTROPODS
- *Worthenia*
- *Soleniscus*
- *Ianthinopsis*

PELECYPOD
- *Astartella*

CRINOIDS
- Columnals

GEOLOGY. The Ames at this locality is composed of clayey limestone and very limy shale. It is a rock easily broken apart; thus the fossils are easily extracted. The Ames limestone is one of the many, thin Pennsylvanian Period limestones that are found underlying and overlying the more common coal-bearing non-marine shales and sandstones which are so prevalent in western Pennsylvania. The many fossils, particularly the brachiopods, show that the Ames was deposited in marine rather than fresh waters. As such it represents one of the recurring periods of time during the Pennsylvanian Period when the coal swamps disappeared from this part of Pennsylvania and normal sea waters with its flourishing marine life inundated the land. When the marine waters left the area swamps formed again and sandstones, shales and coal were deposited over the limestone.

Many abundantly fossiliferous outcrops may be explored in Allegheny County. If you wish to visit some of the exposures not cited in this book write to the Carnegie Museum, 4400 Forbes Avenue, Pittsburgh for a list of the fossiliferous localities.



LOCATION. Excellently preserved fossils may be collected from exposures of the Pennsylvanian Vanport limestone in Armstrong County. The area in which good fossils may be collected is about 0.5 mile north of U. S. 422 at a point nine miles west of Kittanning. The exposure is 2.7 miles northwest of Worthington and 0.9 mile east of the boundary line between Butler and Armstrong Counties. In this area several coal strip mines have exposed the limestone. Quarries in the limestone are being operated just north of U. S. Route 422. These quarries occasionally contain good fossils but change a great deal due to continuing operation. About 0.2-0.3 mile northwest of the quarries, however, is an abandoned coal strip mine in which the limestone is well exposed. The soil has been removed from the limestone over a considerable area and, as a result, weathering of the limestone has revealed many fossils and freed many of them from the rock. Access to the strip pit is achieved by traveling north along the dirt road that intersects with U. S. Route 422, 0.7 mile east of the county line. A haulage road leads east to the strip mine, at a point 0.5 mile north of the U. S. highway. The strip mine cannot be seen from the road intersecting with the U. S. highway. Collectors must walk east across a low rise about 300 feet to the strip mine.

FOSSILS. This locality contains an abundance of large crinoid columnals. Pieces may be extracted that are three to four inches long and up to one inch in diameter. One nearly complete stem about three feet long was observed in place. In addition countless specimens of the coral *Lophophyllidium* may be collected. The best place to look for these, plus other fossils, are in the layers one to two feet below the top of the limestone. The fossils collected here are illustrated in Plates 8 and 9.

BRACHIOPODS
- *Composita*
- *Linoproductus*
- *Phricidothyris*

GASTROPOD
- *Euconospira*

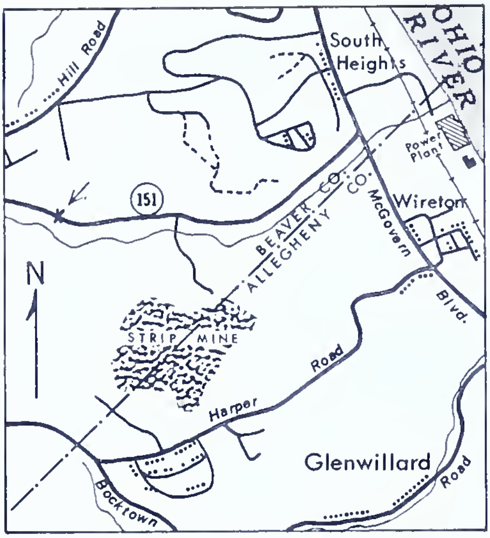
COELENTERATE
- *Lophophyllidium*

CRINOID
- Columnals

ECHINOID
- Spines and plates

GEOLOGY. The limestone exposed in the strip pit is the Vanport limestone. This limestone was deposited during the Pennsylvanian Period nearly 295 million years ago. Conditions in the marine sea which covered Pennsylvania during this period of the earth's history must have been conducive to the abundant growth of corals and crinoids. The large columnals indicate that the crinoids were very large. None of the calices are preserved.

LOCALITY 4—BEAVER COUNTY



LOCATION. Three miles south of the center of Aliquippa and just across the Ohio River from Ambridge, the Pennsylvanian Ames limestone is well exposed in a new road cut along Pa. Route 151. The very fossiliferous three to four foot thick limestone bed crops out on the north side of the highway in a steep bank. The exposure is 0.7 mile west of the intersection of Pa. Route 151 and McGovern Boulevard which extends through the Borough of South Heights. Caution should be exercised while crossing the road and collecting at this exposure. The highway is heavily traveled and there is only a few feet of shoulder between the pavement and the steep bank where the limestone is exposed. There is, however, a wide pull off area south of the highway so that cars may park without difficulty.

FOSSILS. The Ames limestone at this exposure is largely made up of many fragments of crinoids. Separated pieces of the stem, body (calyx) and "arms" (ambulacra) are very abundant. A few specimens with the calyx plates still attached together have been found at this locality. Usually after the death of a crinoid, the many fragments that make up the stem, body and arms were scattered by scavengers and water currents. In addition to crinoid fragments many other genera may be found at this exposure. These are illustrated in Plates 8 and 9 and are listed below.

BRACHIOPODS
- *Composita*
- *Crurithyris*
- *Hustedia*
- *Marginifera*
- *Rhipidomella*
- *Wellerella*

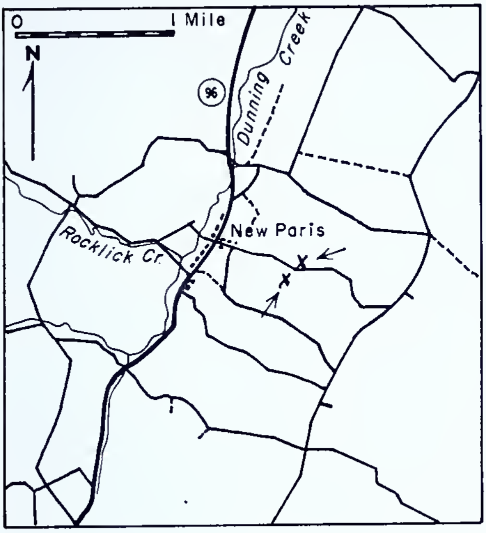
CORALS
- *Lophophyllidium*

CRINOIDS
- *Aatocrinus*

TRILOBITES
- *Kaskia*

GASTROPODS
- *Schizostoma*

GEOLOGY. The Ames limestone at this exposure is largely composed of calcareous claystone and fossil fragments. The rock is relatively fresh at this locality but because of the large amount of clay contained in the rock it disintegrates after short exposure to weathering and many of the fossils are thus freed from the rock and can be gathered up loose. The origin of the Ames is discussed under Locality 2, Allegheny County where the rock is also well exposed. The fossil content of the limestone differs considerably between the two exposures even though they originated in the same body of water. Brachiopods are most common at Locality 2, crinoids at Locality 4. The difference may be due to the fact that one of the exposures may originally have been nearer to shore, or the currents were different. Crinoids are usually associated with bodies of water with few currents.



LOCATION. Two abandoned limestone quarries four miles north of Schellsburg are good localities for collecting Early Devonian Period fossils. The two quarries are 0.6 mile east of New Paris and Pa. Route 96 on a country dirt road. The first quarry is a few feet north of the road and is easily seen. The second quarry is about 700 feet due southeast of the roadside quarry. The second quarry is overgrown with brush and its location is shown by an old lime kiln that can be seen from the roadside quarry. The second quarry is about 50 feet south of the lime kiln on the hill side and is on private property, now used as an orchard. Permission should be secured before visiting this quarry.

FOSSILS. Some large and robust brachiopods *(Eospirifer* and *Leptostrophia)* may be collected at these quarries. Nearly all the fossils are silicified; the original calcium carbonate shell material of the fossils has been replaced by silica. Silica is very resistant to weathering processes while the limestone is not. Thus, many of the fossils have been freed from the limestone by the gradual dissolving of the limestone. The fossils to be collected at this locality are listed below and figured on Plates 4, 5 and 6.

BRACHIOPODS
- *Eospirifer*
- *Gypidula*
- *Leptaena*
- *Leptostrophia*
- *Rhipidomella*
- *Uncinulus*

CRINOID
- Columnals

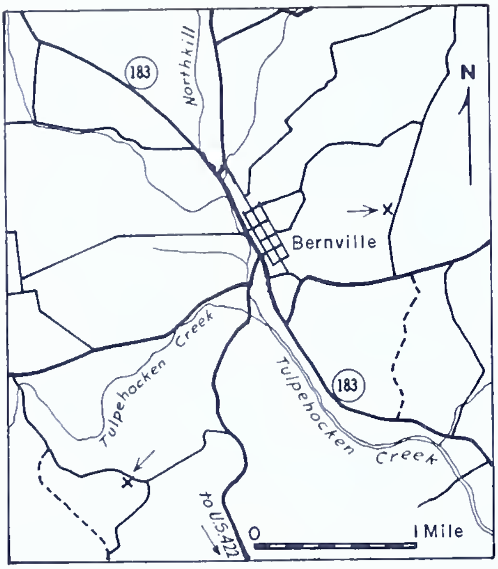
TRILOBITE
- *Phacops*

COELENTERATE
- *Stromatopora*
- *Streptalasma*

GEOLOGY. The rocks exposed in the quarries are called the "Helderberg" limestones. They were deposited in a marine sea about 405 million years ago. Two types of rock, limestone and chert, are predominant at these quarries. The chert is generally interlayered with the limestone. Chert, which is composed entirely of silica, apparently replaced part of the limestone after the limestone had been deposited. Exactly how this replacement took place is an unsolved geologic problem. At the same time that the limestone was replaced, many of the fossils in other parts of the limestone were also changed to silica. Why the fossils were replaced and not all the limestone is still an unsolved question.

Solution of the limestone by water has enlarged some of the large natural fractures (joints) seen in the second quarry. One of these extends into the earth a considerable distance and may open into a cave. Caution should be exercised not to fall into this cave in the floor of the quarry.

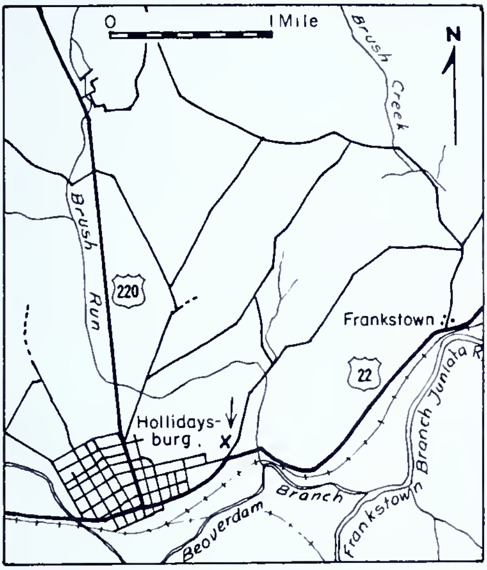
LOCALITY 6—BERKS COUNTY



LOCATION. Berks County does not contain rocks which are very fossiliferous. In some of the shales south of Bernville, however, a few graptolites have been found. The fossils are in two small road-side exposures 0.8 mile east of Bernville and 1.8 mile southwest of Bernville. The exposure east of Bernville is a small road cut through a low knoll; fossils are found on both sides of the road. The exposure southwest of Bernville is a low bank on the south side of the road where it has been scraped off. Fossils may be found along this bank for a distance of about 100 feet. The best approach to these locations is to follow Penna. Route 183 to the blinker light in Bernville and then follow the roads indicated on the map.

FOSSILS. Only graptolites (Class Graptolithina) have been found at this locality. Two genera, *Climacograptus*, characterized by a single rhabdosome with theca on each side, and *Dicellograptus*, characterized by two rhabdosomes joined in the shape of a V with theca on the outside of the V, are present in the shales of the exposure. The fossils are shown on Plate 2.

GEOLOGY. The rocks exposed at locality 6 belong to the Martinsburg Formation. They were deposited during the Ordovician Period about 450 million years ago. Much of the Martinsburg Formation, which underlies large areas of Pennsylvania from Franklin to Northampton Counties contains no fossils. For several reasons, during the deposition of the Martinsburg Formation, animals were not able to live on the sea bottom where the rocks were being formed, thus no fossils remain. The few fossils found are ones that lived at the surface of the sea, much like living sea weed and jelly fish. These (the graptolites) floated out to sea and when they died their chitinous exoskeletons sunk to the bottom and were buried. Contributing reasons to the absence of other fossils may have been that the sea was too muddy, the currents too swift or there was not enough food for the animals. It is also possible that the sea water in which the Martinsburg was deposited selectively dissolved carbonate shelled animals that may have lived on the sea bottom. The chitinous skeletons of the graptolites were not dissolved and thus remain as fossils.



LOCATION. Very well preserved Silurian Period fossils may be collected in abundance near Hollidaysburg. The fossil locality is 0.6 mile east of the junction of Routes 22 and 220 in Hollidaysburg, just east of the borough line. The exposure is 0.1 mile north of U. S. Route 22 and lies about 50 feet west of the paved road that parallels Brush Run. The exposure is in a large area from which soil and bed rock have been stripped. Access to the exposure is easily made from the paved road and cars may park in the stripped area itself. The fossils are found concentrated into several bands of a few feet width that extend north and south across the exposure.

FOSSILS. This locality is noted for the thousands of well-preserved small brachiopods that may be collected. It is also noted for the uncountable thousands of microscopic ostracodes that, in some cases, entirely make up some layers of the rock. Plates 3 and 4 illustrate the fossils listed below.

BRACHIOPODS
- *Dalmanella*
- *Stegerhyncus*
- *Uncinulus*
- *Whitfieldella*

CORALS
- *Coenites*
- *Favosites*

CRINOID
- Columnals

BRYOZOAN
- *Rhombotrypa*

OSTRACODES
- *Kloedenia*
- *Velibeyrichia*

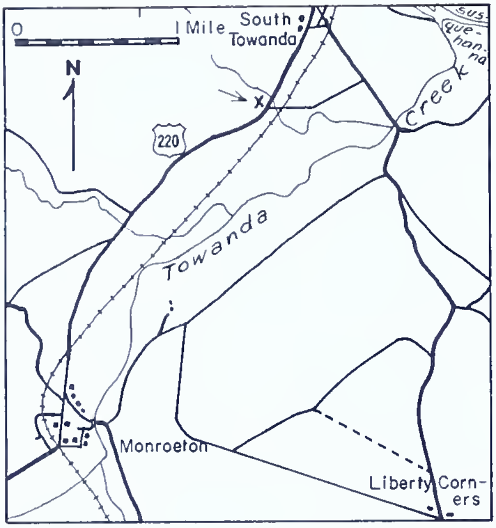
CEPHALOPOD
- *Michelinoceras*

PELECYPOD
- *Liopteria*

GASTROPOD
- *Hormotoma*

GEOLOGY. The rocks at this exposure show an irregular alteration of fossiliferous limestone and non-fossiliferous shaly limestone and shale. The fossiliferous limestone makes up only a small part of the total rock exposed. Each of these fossiliferous zones marks a time during the deposition of the limestone and shale when abundant marine life was able to flourish. The barren or non-fossiliferous parts of the rock mark periods of time when animals could not live where the rock was being deposited. One of the reasons for this may have been that the fine clay which formed the shale made the sea waters too muddy for animal life. During those periods of time when the water wasn't muddy, animals could live on the sea bottom. Thus, we have their fossil record in the form of thin fossiliferous limestone interlayered with non-fossiliferous rocks.

This locality also contains a few layers of "fossil ore", fossiliferous limestone layers which have been partly replaced by hematite. These limestones are reddish and were used as a source of iron ore during the early 1800's.



LOCATION. Bradford County has many fossiliferous exposures. One of these is located along the west side of U. S. Route 220 2.5 miles north of Monroeton and 0.75 mile south of South Towanda. The fossils are in a road cut on the west side of the highway directly across from a country road leading to the east. It is best to park vehicles on the east side of the main road where more space is available. Exercise caution crossing the highway. The fossils may be found in loose blocks over the entire exposed slope but many of the best fossils may be collected on the bench about 15 feet above road level. Collecting along the bench is much safer than along the road level.

FOSSILS. Many of the fossils at this exposure consist only of internal and external molds and casts. Some of the fresher, unweathered portions of the rock still contain fossils with the shell material preserved. Brachiopods, particularly members of the genus *Cyrtospirifer*, are most common. The fossils listed below are figured in Plates 5, 6, 7 and 8.

BRACHIOPODS
- *Ambocoelia*
- *Chonetes*
- *Cyrtospirifer*
- *Tylothyris*
- *Whidbornella*

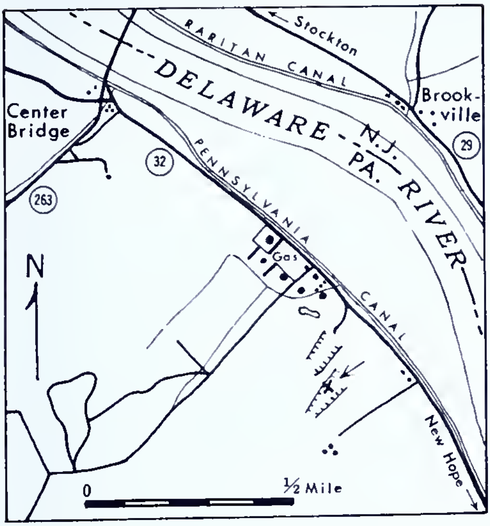
PELECYPOD
- *Grammysia*

GASTROPOD
- *Holopea*

CRICOCONARID
- *Tentaculites*

CRINOID
- Columnals

GEOLOGY. The fossils at this locality are from Late Devonian Period rocks called the West Falls Group. Their age is approximately 360 million years old. The rocks exposed at this locality are typical of the region. They consist mainly of shale, siltstone and sandstone; limestone is absent. All the calcium carbonate present in the rocks comes from the shells of the fossils. The rocks are the types that result from mud and sand being swept into a marine sea by streams. During most of the time that these rocks were being deposited, the water was too muddy and the currents too strong for animals to live on the sea bottom. At times, however, animals flourished when the currents were less strong and the water was clear. Most of these animals were large brachiopods and other types that could live under the conditions of the Devonian seas. Often, after death of the animals, the strong currents would wash them to and fro on the sea bottom and concentrate them in pockets. Only the relatively thick shelled animals could survive such rough treatment, thus the fossils are predominantly of this type.

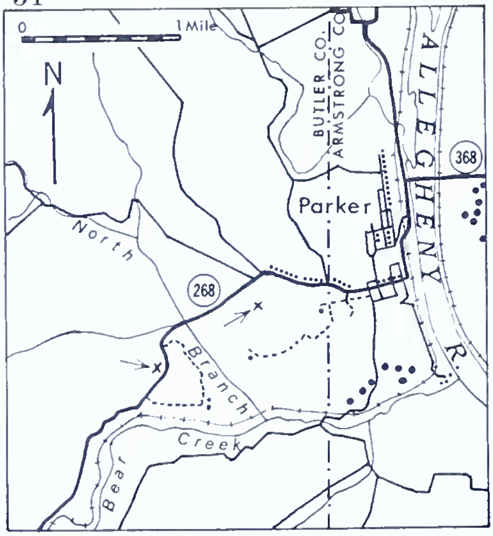


LOCATION. Bucks County is nearly everywhere underlain by unfossiliferous rocks. In the Buckingham Valley area, however, many abandoned limestone quarries are present. Fossils may be found in these quarries in what are nearly the oldest sedimentary rocks in Pennsylvania. Two of these quarries are along the west bank of the Delaware River north of New Hope and across the river from Stockton, New Jersey. The quarries are 0.9 mile southeast of the intersection of Pa. Routes 263 and 32 in Center Bridge. The quarries, which are not visible from the state highway, are approached by an old road (south of several oil tanks) that extends west from Pa. Route 32 past a partly demolished building. The quarry road leads directly into the most northerly of the two quarries. The fossils, however, are found in the southernmost quarry about 300 feet south of the larger, main quarry. To get to the smaller quarry it is necessary to walk south past a series of old lime kilns and then west along an overgrown, low area until rock outcrop is seen. The fossils are found in the limestone beds near the base of the exposure and are found only in a few beds. The whole area is overgrown with many trees and underbrush and may be difficult to find.

FOSSILS. Two kinds of fossils, trilobites and brachiopods, are found in these rocks. The trilobites, represented by the genus *Welleraspis* are very common in some beds. The brachiopods are represented by the genus *Linguella,* which is very rare. These fossils are illustrated in Plate 1. Other fossils are not found here. The trilobite *Welleraspis* is represented by many specimens of cephalons and pygidia ("heads and tails"). Few of the segments that make up the thorax (body) or the "free cheeks" have been found. The cephala and pygidia are roughly the same shape and size whereas the other parts are smaller and differently shaped. Perhaps the currents in the sea in which the trilobites lived washed the various pieces about after death of the animal and those of similar size and shape were concentrated.

GEOLOGY. The limestones in the Bucks County quarries are part of the Conococheague Formation. They were deposited during the latter part of the Cambrian Period, approximately 520 million years ago. The Cambrian Period includes some of the oldest known sedimentary rocks which contain fossils. It was at or near the beginning of this Period that animal life on the earth first was able to build skeletons or shells. Only a few groups of animals were prevalent then.

LOCALITY 10—BUTLER COUNTY



LOCATION. Many strip mines in the northeastern corner of Butler County contain exposures of fossiliferous limestones. Two of these limestone exposures are recommended as fossil collecting localities. The two strip mines are adjacent to Pa. Route 268 in the area 0.5 to 1.5 miles southwest of Parker. The area is just east of the line between Butler and Armstrong Counties. The first strip mine exposure is visible from the State Highway and is about 300 feet south of the highway at a point one mile west of the Allegheny River in Parker. It is 0.5 mile northeast of the Pa. Route 268 bridge over the North Branch of Bear Creek. The second strip mine exposure is 0.8 mile southwest of the first exposure. It is about 200 feet west of the highway but is not visible from the road due to the large dump pile adjacent to the road. At both exposures the limestone is exposed near the top of the strip mine highwall and many blocks have tumbled to the floor of the mine. The steepness of the wall at the first exposure makes it dangerous to collect from the limestone in place. The loose blocks on the mine floor, however, contain many fossils. The shale which directly underlies the limestone also contains good fossils. These are much easier to extract than those in the limestone.

FOSSILS. Brachiopods are the most common fossil to be found at this locality. Several genera may be collected at these two strip mines. The fossils listed below are illustrated in Plates 8 and 9.

BRACHIOPODS
- *Chonetes*
- *Dictyoclostus*
- *Hustedia*
- *Phricidothyris*
- *Spirifer*

COELENTERATE
- *Lophophyllidium*

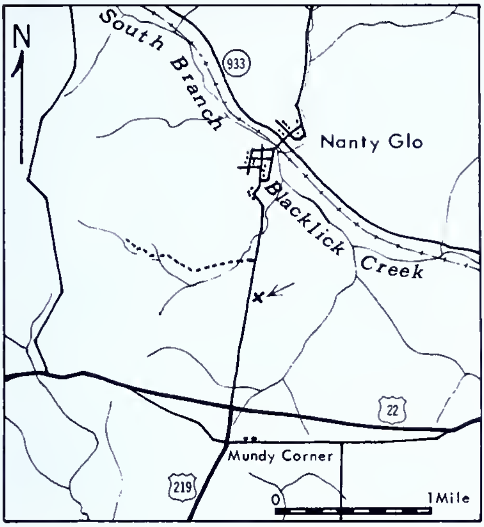
BRYOZOAN
- *Rhombopora*

CRINOID
- Columnals

GASTROPOD
- *Shansiella*

ECHINOID
- Spines and plates

GEOLOGY. The fossils at these localities come from the Vanport limestone and its underlying shale. They were deposited in the Pennsylvanian Period about 295 million years ago. When the marine sea in which these rocks were formed first invaded this area, the rivers and streams flowing into it were carrying a great deal of sediment. This sediment was deposited as mud and formed the fossiliferous shale. As the streams carried less and less mud to the marine sea the water cleared and limestone was deposited.



LOCATION. An exposure of the Ames "limestone" south of Nanty Glo is one of the few places in Cambria County where fossils of animals that lived in marine waters may be collected. Many of the rocks in Cambria County contain plant fossils. These are usually associated with strip mines which constantly change and thus are not generally suitable for fossil collecting. The exposure of the Ames is located 0.7 mile north of the intersection of U. S. Route 22 and Pa. Route 933. The exposure is 1 mile south of Nanty Glo where the highway cuts through a steep hill. The fossils are found in the few inches of calcareous shale overlying the coal bed exposed in the steep bank. Due to the steepness of the bank and the narrowness of the shoulder, collecting at this outcrop may be dangerous and should be approached with great caution. It would be best to park vehicles at the top of the hill and walk north along the road to the outcrop.

FOSSILS. The fossils included in the Ames at this locality are much different from the fossils found in the Ames in the Allegheny, Beaver and Westmoreland County localities. In the latter three localities brachiopods and crinoid fragments are most common. The Cambria County locality is almost entirely made up of pelecypods and gastropods. The fossils at this locality are almost entirely molds and casts because the original shell material has been removed. The snails are mostly represented by "steinkerns", the internal filling of the snail shell. The fossils listed below are illustrated on Plates 8 and 9. Many specimens of the rock also contain ostracodes but most of these are so tiny that a microscope is needed to see them. The genus *Roundyella* is identified by the finely pitted pattern of its exterior.

PELECYODS
- *Astartella*
- *Aviculopecten*
- *Nucula*

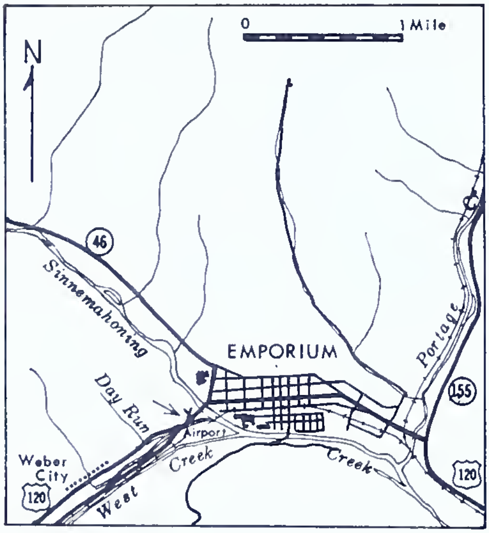
GASTROPODS
- *Euphemites*
- *Loxonema*
- *Euomphalus*
- *Shansiella*

TRILOBITE
- *Phillipsia*

OSTRACODES
- *Roundyella*
- *Fabilicypris*
- *Hollinella*

GEOLOGY. The Ames "limestone" is not really a limestone at this locality but is or was originally a calcareous shale. Nearly all the calcium carbonate has been dissolved out leaving only the shale and the molds of fossils. The fact that this is a shale and not a real limestone indicates that when this rock was formed it may have been nearer to the shoreline of the sea in which the Ames was deposited.

LOCALITY 12—CAMERON COUNTY



LOCATION. Just west of Emporium along U. S. Route 120, fossils from Devonian Period marine sediments are found. The exposure is in the oldest known surface rocks in the county. The outcrop is on the north side of the highway about 200 feet west of the bridge over the creek at the western borough limit of Emporium. Ample space is available for parking both on the north side and south side of the highway. Fossiliferous rocks are scattered all over the cut bank and also may be found in the exposure.

FOSSILS. The fossils found at this exposure are typical of the Devonian rocks of other areas in Pennsylvania. Brachiopods make up the majority of the fossils. Bryozoans, however, may be found nearby filling some of the thin layers. Most of the fossils are represented only by molds. Some of the bryozoan layers, however, contain original shell material where the rock is not deeply weathered. Fossils found at this exposure are listed below and illustrated in Plates 5 and 7.

Brachiopods
- *Athyris*
- *Atrypa*
- *Camerotoechia*
- *Cyrtosprifier*
- *Whidbornella*

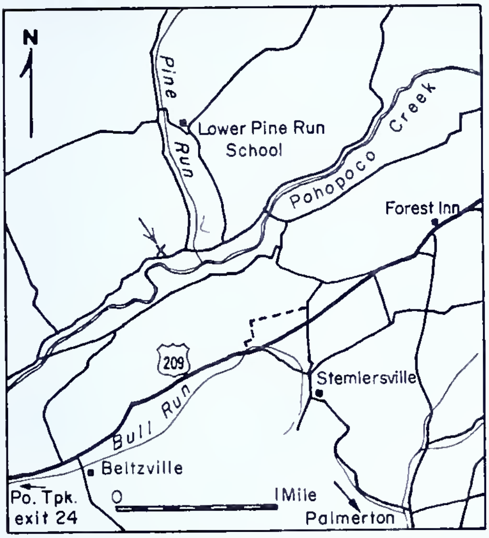
Celhalopod
- *Michelinoceras*

Bryozoan
- *Batostomella*

Crinoid
- Columnals

GEOLOGY. Cameron County is nearly everywhere underlain with nonmarine rocks of Late Devonian to Pennsylvanian age. Where the Driftwood Branch of the Sinnemahoning Creek has eroded these Devonian and Pennsylvanian Period rocks, older and older layers are exposed in its banks. In the region of Emporium, the creek has cut through the nonmarine rocks and exposed in the lowest part of the valley the fossiliferous Middle Devonian age marine shales and sandstones. These rocks represent the most recent time that marine waters covered this part of Pennsylvania. These rocks are about 365 million years old. From that time until now marine seas have not existed in this part of Pennsylvania. The remaining layers of rock above the fossiliferous area were deposited in fresh water lake, swamp, stream and river beds. The change from rocks formed in a marine environment to those formed in a nonmarine environment is marked in the Emporium area by the oldest red layer. Below this red layer rocks are generally marine in origin. Above it they are generally nonmarine. Few fossils are found in the red-colored layers except for occasional fragments and scales of fresh water fishes.

LOCALITY 13—CARBON COUNTY



LOCATION. One of the best and most prolific fossil collecting localities in Pennsylvania occurs in Carbon County. The exposure is about 2.5 miles east of the Mahoning Valley Exit of the Northeast Extension of the Pennsylvania Turnpike on the north side of Pohopoco Creek. The outcrop is a steep bank on the north side of the county road 0.15 mile west of the intersection of the road leading north along Pine Run. The simplest approach to the exposure is to cross the bridge over Pohopoco Creek at the Turnpike exit and travel east along the county road which parallels the creek. The exposure may be reached also by following the county road that leads north off U. S. Route 209 near Forest Inn. Fossils are found throughout the loose blocks and in place high on the bank.

FOSSILS. This locality has a wide variety of fossil genera and specimens. Unfortunately all original shell material has been dissolved away so that only molds and casts remain. These, however, preserve the details of the fossils with great fidelity. These fossils are illustrated on Plates 5, 6 and 7. The coral genus *Trachypora* is characterized by a long winding tube-like mold with tiny inward projecting cones. These cones are the mud fillings the cavity in which the individual coral polyp lived. In addition to the ubiquitous columnals of crinoids, molds of the very delicate ambulacra (arms) have been found.

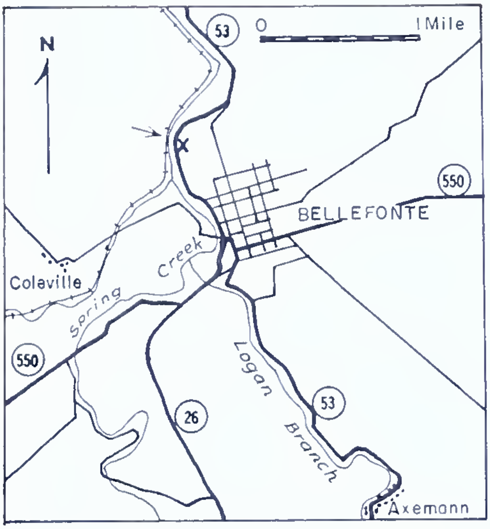
BRACHIOPODS
  Ambocoelia
  Camerotechia
  Chonetes
  Douvillina
  Elthya
  Leiorhynchus
BRYOZOA
  Fenestella
  Sulcoretopora
  Taeniopora
COELENTERATES
  Aulopora
  Trachypora

  Mediospirifer
  Mucrospirifer
  Protoleptostrophia
  Rhipidomella
  Tropidoleptus
  Tylothyris
TRILOBITES
  Dechenella
  Greenops
  Phacops
  Trimerus

PELECYPODS
  Actinopteria
  Aviculopecten
  Cypricardina
  Leiopteria
  Paleoneilo
CEPHALOPOD
  Michelinoceras
OSTRACOD
  Hollinella
CRINOIDS
  Columnals
  Ambulacra

GEOLOGY. The rock exposed at this locality is about 320 million years old and is called the Mahantango Formation. The multitudinous fossils represent a time of prolific life on the Devonian sea bottom.

LOCALITY 14—CENTRE COUNTY



LOCATION. Many of the Ordovician Period limestones that underly the Nittany Valley are fossiliferous. An exposure of some of these fossiliferous limestones is found just north of the town of Bellefonte. The rock outcrop is on the east side of Pa. Route 53, 200 to 500 feet south of Sunnyside Blvd. It is 0.8 mile north of the intersection of Pa. Routes 53 and 550 in Bellefonte. Fossils are found in the large cut where the layers of limestone are prominently exposed. The best fossils, many of which have weathered free from the limestone and interlayered shale, are found near the north end of the exposure. Directly opposite Sunnyside Blvd., rocks of different character contain additional fossils.

FOSSILS. Excellent specimens of some brachiopods, notably *Dalmanella* and the small bryozoan *Prasopora* weather free of the enclosing rock and may be collected whole. Careful examination will turn up many of the very small fossils. Plates 1 and 2 illustrate some of the fossils found at this locality.

BRACHIOPODS
- *Dalmanella*
- *Rafinesquina*
- *Sowerbyella*

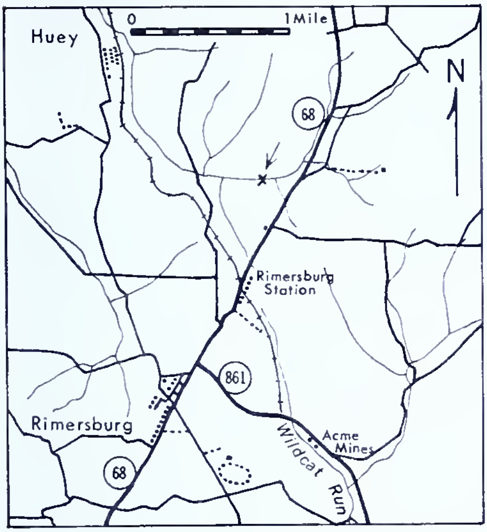
TRILOBITES
- *Cryptolithus*
- *Flexicalymene*
- *Triarthus*

BRYOZOA
- *Hallopora*
- *Prasopora*

CRINOID
- Columnals

GEOLOGY. Two formations are exposed at this locality. The rocks exposed opposite Sunnyside Blvd. belong to the Reedsville Formation. These are brownish calcareous sandstones and shale that contain the trilobite *Triarthus*. The rock to the south of the Reedsville is the Coburn Formation (Trenton Group). It is composed of interbedded layers of shale and limestone. Some limestone layers are almost entirely made up of fossil debris. Both of the formations are about 445 million years old.

The thin interlayering of fossiliferous and non-fossiliferous shales and limestones indicate changes in the character of sedimentation and life on the Ordovician sea floor. Shales indicate periods of muddy waters with sediment coming from rivers and streams. The muddy water prevented abundant life, thus not as many fossils are found in the shales as in the limestones. Limestone indicates clear water with precipitation of lime and accumulation of carbonate shells of dead animals. Some of the limestone layers lack fossils. These may have originated by precipitation of calcium carbonate under certain conditions unfavorable to animal life.



LOCATION. Clarion County is fortunate in having rocks associated with coal-bearing deposits which contain excellently preserved marine fossils. The locality selected for this county is about 12 miles southwest of Clarion near the town of Rimersburg. The exposure of the fossiliferous rock is in an abandoned coal strip mine 1.5 miles north of Rimersburg. The strip mine is about 200 yards west of Pa. Route 68 at a point 1.2 miles north of the intersection of Pa. Routes 68 and 861 in Rimersburg. It is best to park vehicles along the main highway and walk westward along the small stream which leads toward the strip mine. The fossiliferous rocks are exposed at the base of the strip mine wall at the point where the stream enters the mine. Fossils may be collected from the rock at this point or from the innumerable blocks of rock on the immediately adjacent dump pile.

FOSSILS. This locality is unusual because of the extreme profusion of two genera of brachiopods. The genus *Marginifera* occurs by the hundreds and may be found in the iron-rich layer just above the coal bed. Many blocks of this iron layer are on the dump pile. The genus *Mesolobus* occurs in even greater numbers in the black shales which overlie the iron zone. Blocks of this shale are also common on the dumps. These plus the other fossils found at this locality are illustrated in Plates 8 and 9.

BRACHIOPODS
- *Lingula*
- *Linoproductus*
- *Marginifera*
- *Mesolobus*

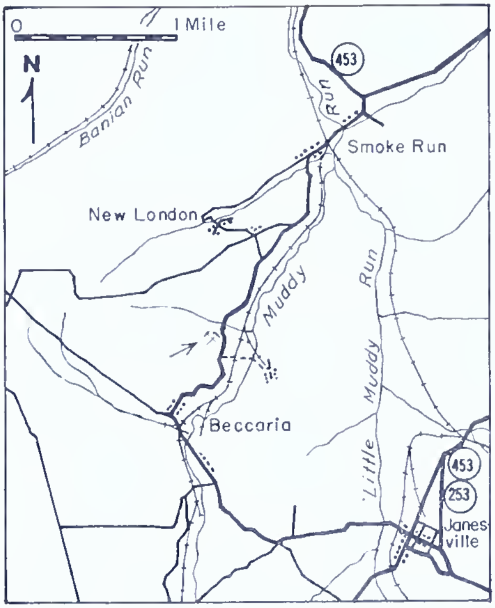
GASTROPODS
- *Euphemites*
- *Straparollus*
- *Worthenia*

PELECYPOD
- *Nucula*

CEPHALOPOD
- *Michelinoceras*

GEOLOGY. The fossiliferous shale and iron layer at Rimersburg is called the Columbiana shale. The fossils represent a rapid change in the life environments that occurred in this part of Pennsylvania during the formation of some of the coal-bearing rocks. The coal was deposited in a swamp on land. Within a short time after the swamp was filled with plant material which became coal, the swamp was covered by marine waters. This was probably caused by the land lowering slightly. With the sea waters came a profusion of marine life. The many thousands of fossils represent a period when abundant food must have been available in the sea. The increasing amount of mud that was deposited in the sea made it difficult for many of the animals to continue living here and they were gradually killed off.

LOCALITY 16—CLEARFIELD COUNTY



LOCATION. Clearfield County is well known for its nonmarine coal-bearing rocks. The nonmarine rocks generally are not abundantly fossiliferous. Fossils may be collected, however, from the nonmarine rocks in a strip mine which exposes the "D" or Moshannon coal. The locality is along the road leading south from Smoke Run to Beccaria. The strip is on the northwest side of the road 0.6 mile north of Beccaria but is not visible from the road. Access to the exposure is by a haulage road that leads from the county road to the strip pit. The fossils are found in the first foot or so of shale that directly overlies the "D" coal. This coal is exposed in several places in the pit.

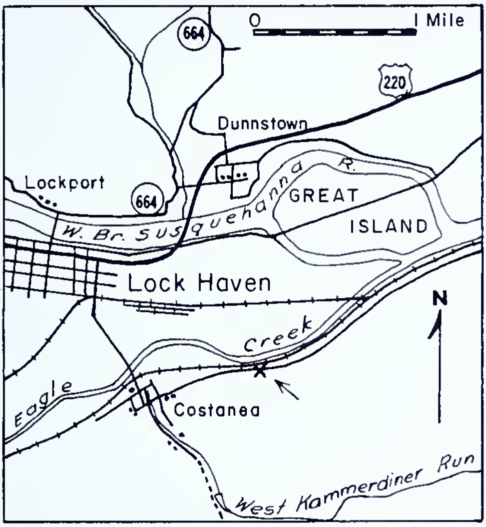
Some of the nonmarine rocks in Clearfield County, particularly those associated with strippings on the "C" or Middle Kittanning coal, contain excellent plant fossils. One of the best of the "C" exposures is on Coal Hill just west of the Clearfield Borough limits. Strip pits are frequently covered over and thus collecting fossils from them cannot be assured for any length of time.

FOSSILS. The fossils listed below are illustrated in Plate 10.

Plants
- *Pecopteris*
- *Neuropteris*
- *Calamites*

Conchostraca
- *Pseudoestheria*

GEOLOGY. Each of the coal horizons represents a relatively long period of time when many kinds of trees, ferns and other plants prolifically grew in swamps. Periodically, streams carrying mud and sand swept over these swamps depositing their contained sediment. These streams also carried plant material from nearby swamps and deposited it with the mud. The fresh water Conchostracan *Pseudoestheria* lived on the dead and decaying plant material and upon its death was also buried in the mud. Thus, we have at the Clearfield locality evidence of several environments and changes in environments. First, a swamp environment rich in organic matter is represented by coal; secondly, a muddy stream environment is represented by the roof shale. Above this is sandstone indicating rapid stream deposition. The presence of the plants in the shale is evidence of the nearby swamps. *Pseudoestheria* is additional evidence of the freshness of the water in which the muds were deposited. Each of these environments was repeated many times during the Pennsylvanian Period, 300 million years ago.

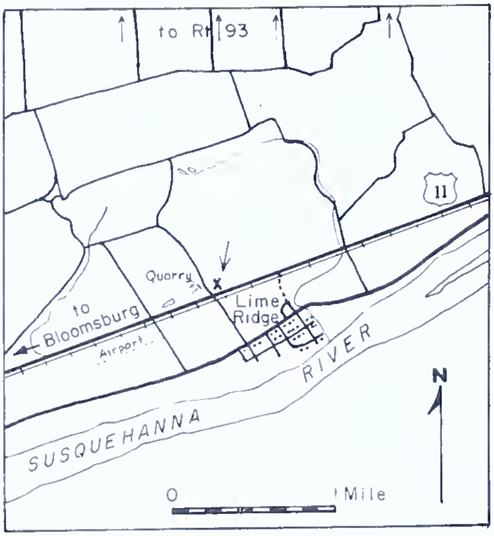


LOCATION. A road cut through an ancient bioherm (coral reef) southeast of Lock Haven is an excellent place to collect Silurian Period corals. The exposure is 1 mile southeast of the eastern part of Lock Haven. It is reached by turning south off U. S. Route 220 in the eastern part of the town of Lock Haven and following the signs to the village of Castanea. The outcrop is 0.8 mile east of Castanea on the dirt road to McElhattan. The collecting locality is along the southern bank of the dirt road. The bioherm (reef) is exposed in the area near telephone pole LY-LH-25-16 at the eastern end of the exposure. Other fossils are found in the shales and limestones east of the bioherm.

FOSSILS. The most abundant fossils of this locality are the corals which built the reef. The massive and tubular coral *Favosites* is found here by the hundreds in masses up to bushel-basket size. Many very fine small hand specimens may also be collected here. The small and slender coral *Coenites*, which looks much like some bryozoan genera, is also common in a few layers. Illustrations of the fossils listed below are found in Plates 3 and 4.

COELENTERATES	BRACHIOPODS	OSTRACOD
Favosites	*Reticularia*	*Kloedenella*
Coenites	*Stegerhynchus*	

GEOLOGY. Coral reefs are not often preserved in rocks. Silurian Period rocks (420 million years old), however, are well known in central and eastern United States for its many large coral reefs. The character of their construction makes them very porous and permeable to fluids and in some areas they are major sources of oil. The coral reef exposed at Castanea is very small and in its present form does not look much like a reef. This is because the rocks are not in their original position and because we can see only a small portion of the reef. The rocks at the locality are called the Mifflintown Formation. Its layers now are vertical or nearly so, but were once parallel to the surface of the earth and were deposited on a sea floor. At scattered places corals began to grow on the bottom of the sea in which these rocks were deposited. The waters must have been warm and not too muddy, and food must have been plentiful in order for the delicate corals to live. Their rapid growth and constant secretion of calcium carbonate built the tiny tube-like skeletons we now see. As one colony died another grew right on top of it.



LOCATION. Approximately five to six miles east of Bloomsburg along U. S. Route 11, Early Devonian Period limestones have been quarried extensively. Many of these limestones are fossiliferous. Numerous fossils may be found in a road cut less than 100 feet north of U. S. Route 11 near Lime Ridge. The exposure is along the county road which crosses U. S. Route 11 and cuts through the ridge 0.35 mile north of the village of Lime Ridge. Fossils are found in the shaly weathered portions of the older road cut nearest to U. S. Route 11. Recent quarrying has exposed a great deal of rock east and west of the country road but the fossils are not apparent in fresh limestone.

FOSSILS. Brachiopods are the common fossils found here. The fossils are similar to ones found at the Bedford, Huntingdon, Mifflin and Synder County localities. The fossils listed below are illustrated on Plates 4 and 5.

BRACHIOPODS
- *Atrypa*
- *Dalmanella*
- *Eospirifer*
- *Meristella*
- *Rensselaeria*

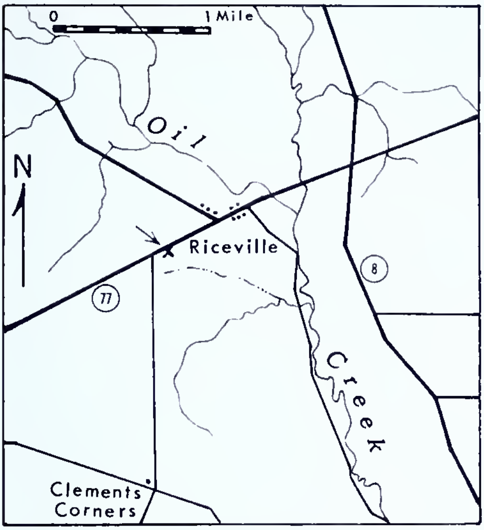
COELENTERATE
- *Cyathophyllum*

PELECYPOD
- *Grammysia*

BRYOZOAN
- *Orthopora*

CRINOID
- Columnals

GEOLOGY. The rock exposed at the Columbia County locality belongs to the "Helderberg" Group of Early Devonian age (400 million years ago). The rock is composed of limestone and calcareous shale. The layers which originally were deposited parallel to the earth's surface now incline to the south at a high angle. This tilting of the rocks occurred about 250 million years ago, long after the rocks were deposited. This was the time that the mountains of Pennsylvania, such as nearby Shamokin Mountain, were formed. The layers of rock, many thousands of feet thick were bent and twisted. Some of them were fractured or broken, producing faults in the earth. On a very small scale many of the layers slid past each other a little bit, much as when you fold a packet of paper or a tablet. This distorted the original shape of the rock and what it contained. Some of the fossils at this locality have been distorted slightly from their original shape by the flexing and moving of layers. Minute fractures, called cleavage, cut across some layers from top to bottom. Movement on these tiny fractures also has caused some distortions of the rock.



LOCATION. In the northeastern part of Crawford County, exposures of some Mississippian Period sandstones contain well-preserved fossil impressions. One of these localities is about 20 miles northeast of Meadville near the town of Riceville. The fossiliferous exposure is a road cut along Pa. Route 77, 1.3 miles west of the intersection of Pa. Routes 8 and 77. The outcrop is 0.35 mile west of the junction of the road to Lincolnville in the town of Riceville. The exposure is on the steep slope of a hill through which the highway cuts. Ample space is available for walking along the sides of the road but vehicles should park either at the base or top of the hill where more space is available. Fossils may be collected from the exposed rock layers and from the many loose blocks that line the banks.

FOSSILS. The Crawford County locality is well supplied with several unusual fossils. This is one of the few localities where impressions of sponges *(Ectenodictya)* may be found. These, however, are very rare even at this locality. The unusual gastropod *Platyceras* is common in some of the layers and is distinguishable by its cone-like appearance. For some reason the snails that bore these shells did not grow them in a spiral manner as do most snails. The brachiopod *Syringothyris* is also common here. This is a spiriferoid brachiopod and is characterized by the steep sides and triangular shape of the one valve. The other valve is nearly flat. The fossils found at this locality are illustrated in Plates 6, 7 and 8.

BRACHIOPODS
- *Buxtonia*
- *Camerotoechia*
- *Rhipidomella*
- *Syringothyris*

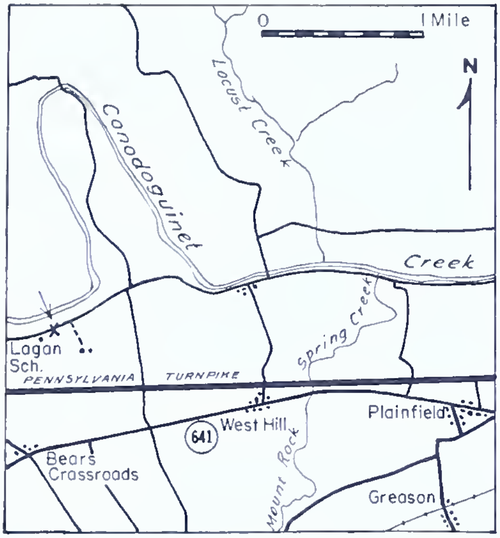
PELECYPODS
- *Paleoneilo*

GASTROPODS
- *Platyceras*

PORIFERA
- *Ectenodictya*

CRINOID
- Columnals

GEOLOGY. The rocks exposed west of Riceville belong to the Corry Sandstone and the Riceville Shale. The Corry is exposed at the top of the section. The diverse rocks of these two units were formed in marine waters. The animals were all types that were adjusted to living on a relatively sandy, muddy sea bottom. The sea water probably had swift currents. The peculiar shape of *Syringothyris* was the result of an animal evolving and becoming adjusted to this kind of environment. The animal lay on the sea bottom with the flat side down and the triangular-shaped shell sticking up into the water. This gave it a solid footing so that it couldn't be rolled around.



LOCATION. One of the most abundantly fossiliferous localities occurs in Cumberland County about 8 miles west of Carlisle. The locality is along a paved county road paralleling Conodoquinet Creek 2.7 miles northwest of Plainfield. The collecting locality is a steep cut bank about 600 feet long on the south side of the paved road in view of the creek. The best approach to the locality is to take one of the dirt or paved roads leading north from Pa. Route 641 west of Plainfield to where they intersect with the road parallelling Conodoquinet Creek. The paved road leading north from Bears Cross Roads also intersects the road along the creek and the locality may be approached from this direction. The fossils are found in nearly all the loose blocks in the rubble at the base of the cut. They may also be observed in place in the exposure itself.

FOSSILS. Both genera and numbers of individuals are abundant at this locality. In addition to the large number of genera, this locality contains fragments of the genus *Caryocystites* which belongs to the extinct Class Cystoidea of the Phylum Echinoderma. The fossils listed below are illustrated in Plates 1, 2 and 3.

BRACHIOPODS
- *Leptaena*
- *Oxoplecia*
- *Parastrophina*
- *Sowerbyella*
- *Strophomena*

TRILOBITES
- *Bumastus*
- *Calyptaulax*
- *Isotelus*

CYSTOID
- *Caryocystites*

BRYOZOA
- *Eridotrypa*
- *Prasopora*
- *Rhinidyctia*

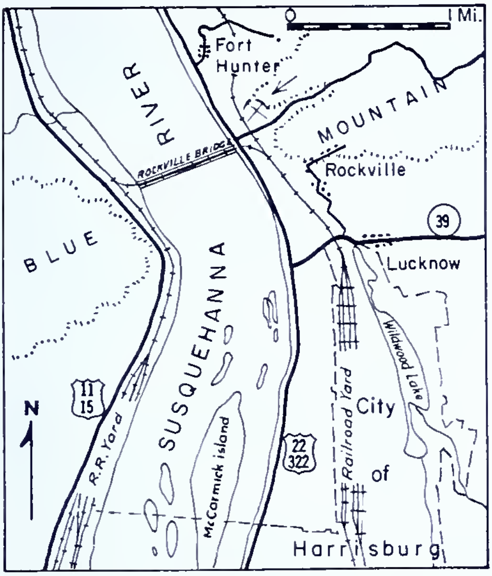
CRINOID
- Columnals

GASTROPODS
- *Hormatoma*
- *Liospira*
- *Lophospira*

COELENTERATE
- *Favistella*

GEOLOGY. The rocks exposed along the Conodoquinet Creek at this locality belong to the Oranda Formation of Middle Ordovician Age (445 million years old). They were deposited in a marine sea which covered much of Pennsylvania. Similar type rocks containing similar fossils are found in limestone valleys throughout central and eastern Pennsylvania. The rocks and fossils indicate a period of time when abundant marine life could flourish on the sea floor. Many of the same age rocks in other areas of Pennsylvania have been metamorphosed and recrystallized. The calcium carbonate of the fossils was changed by the metamorphism with a resultant destruction of the fossils. The Cumberland County locality contains rock layers that were not markedly changed, even though they were tilted nearly vertically. Thus it is one of the few good Middle Ordovician collecting localities.

LOCALITY 21—DAUPHIN COUNTY



LOCATION. The old stone quarries just north of Rockville have been known for many years as a favorable locality for collecting fossils. The quarries are 1 mile north of the northern city line of Harrisburg and are on the west end of the low ridge facing the Susquehanna River. The quarries are 0.15 mile due east of U. S. Route 22. The quarries may be approached by travelling the first eastward leading street north of the large stone-arch bridge (Rockville Bridge) of the Pennsylvania Railroad at Rockville. Continue on the street about 100-200 feet beyond the railroad crossing. To the north a dirt road leads past an electric transformer station and winds around the end of the hill. The dirt road leads to the quarries. While some fossils may be found in all of the quarries the last one to the north is the best and most rewarding for collecting. In this quarry the rocks to the north of the old mine adit produce the best fossils.

FOSSILS. The fossils found at the Dauphin County locality are typical of Middle Devonian age rocks. Brachiopods, especially the spirifers are abundant. Illustrations of the fossils listed below are found in Plates 5, 6 and 7.

BRACHIOPODS
- *Ambocoelia*
- *Athyris*
- *Camerotoechia*
- *Chonetes*
- *Douvillina*
- *Mediospirifer*
- *Protoleptostrophia*
- *Rhipidomella*
- *Spinocyrtia*
- *Spinulicosta*
- *Schuchertella*
- *Tropidoleptus*

PELECYPODS
- *Actinopteria*
- *Leiopteria*
- *Paleoneilo*

BRYOZOAN
- *Fenestella*

CRINOID
- Columnals

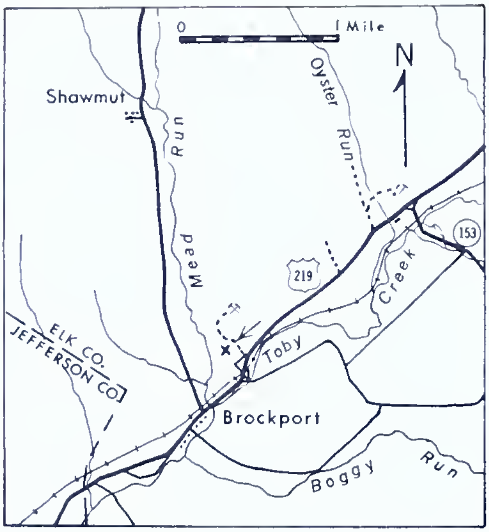
CRICOCONARID
- *Tentaculites*

TRILOBITES
- *Greenops*
- *Phacops*
- *Trimerus*

GEOLOGY. The rock exposed in the quarries is the Montebello member of the Mahantango Formation. Its age is 380 million year old. These rock layers, which are very sandy here, are the same age and contain nearly the same fossils as the exposures in Juniata, Schuylkill and Monroe Counties. These rocks may have been deposited nearer to shore than the shales of the other localities. Rock layers that are made of sand are generally deposited near to the shoreline of the sea.

This locality also contains an "iron ore" layer. It is a thin layer about 50 feet north of the adit (tunnel) and contains oolitic hematite. The little rounded black grains in some of the shales associated with the "ore" are chamosite (iron silicate) oolites.

LOCALITY 22—ELK COUNTY



LOCATION. Along the valley of Toby Creek in the southern part of Elk County, rocks have been exposed in many coal strip mines. Some of the rocks associated with the coal contain marine fossils. One strip mine which exposes these rocks is near the village of Brockport 3 miles west of Brockway and just east of the boundary line between Jefferson and Elk Counties. The strip mine is about 500 feet west of U. S. Route 219 at a point 1.4 miles southwest of the intersection of Pa. Route 153 and the U. S. Highway. The U. S. Highway curves south and crosses Toby Creek at this point. The strip mine may be entered by following the street that leads southwest off the U. S. highway to McLaughlin's Tourist Home. Permission should be obtained before going into the mine. Turn right (north) off the street and follow the dirt road back to the strip mine. The mine has been backfilled so that the fossiliferous rock is no longer exposed in the pit. Many blocks of the fossiliferous shale layer with well-preserved fossils may be found scattered over the dump piles, however.

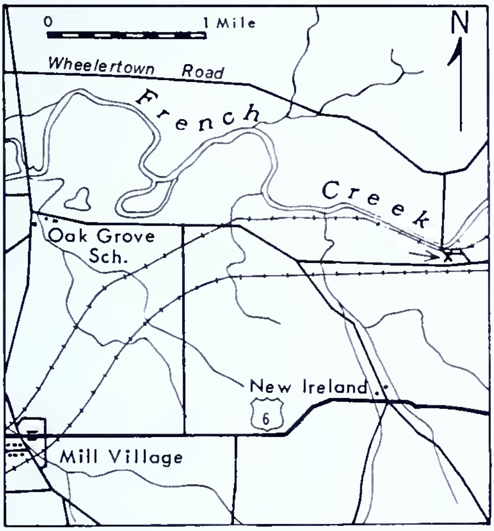
FOSSILS. The Elk County locality contains a number of very fragile fossils that are not often found. One of these is the brachiopod *Linoproductus*. *Linoproductus* is a brachiopod that was covered with long, slender spines while alive. The shell of this animal must have been relatively thin because most specimens of *Linoproductus* are crushed. Careful collecting will produce good specimens of this fossil. The fossils listed below are illustrated in Plates 8 and 9.

BRACHIOPODS
- *Linoproductus*
- *Marginifera*
- *Mesolobus*

PELECYPOD
- *Nucula*

GASTROPOD
- *Euphemites*

GEOLOGY. The fossiliferous rock found on the dump piles at this locality came from a thin, black shale zone that overlies the coal which was stripped from this mine. The fossiliferous shale is called the Columbiana shale and was deposited during the Pennsylvanian Period. It is the same rock that is found at the Clarion County locality. Most of the brachiopods at the Elk County locality are types that had spines on their shells. These spines served the purposes of keeping the animals from being buried in the mud and from being swept away by the sea currents. The water in which the animals lived was marine and was very muddy. Only those few animals adjusted to living in a muddy sea environment could exist here at the time this shale was deposited.



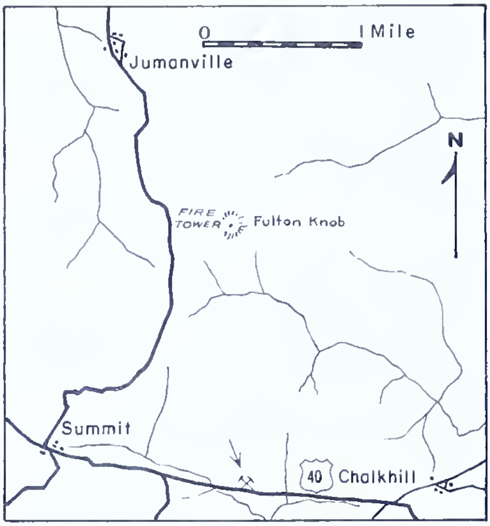
LOCATION. Outcrops of bed rock are scarce in Erie County due to the large amount of unconsolidated sediment left by the passing of the Pleistocene (Ice Age) glaciers. A few outcrops are known, however, and some of these are abundantly fossiliferous. One of these is in a stone quarry, about 3.5 miles west of Union City and 3 miles northeast of Mill Village on the south bank of French Creek. The quarry is on the south side of the country dirt road that crosses French Creek one mile southwest of the LeBoeuf railroad crossing. The quarry may be reached by traveling on one of the county roads leading north from U. S. Route 6 to the road paralleling the Erie Railroad and French Creek. Fossils may be found throughout the quarry in loose blocks and in the quarry wall.

FOSSILS. Many layers of rock in the quarry are filled with very large specimens of the brachiopod genus *Cyrtospirifer*. It is difficult to collect fossils from the layers of fresh rock which still contain the original shell material. In many layers, however, the calcium carbonate is entirely absent and the fossils are represented by innumerable molds. The fossils listed below are illustrated in Plates 6 and 7.

Brachiopods
- *Camerotoechia*
- *Cyrtospirifer*
- *Dalamanella*
- *Schuchertella*
- *Whidbornella*

Pelecypod
- *Leptodesma*

GEOLOGY. The rock exposed in the quarry is called the Panama sandstone and it was deposited near the end of the Devonian Period about 350 million years ago. The absence of fossils in the rock other than the brachiopods, the large size of the *Cyrtospirifers*, and the character of the rock indicate a somewhat unusual environment of its deposition. The late Devonian sea in which the rock was deposited must have been marine in order for the brachiopods to exist. The absence of other kinds of fossils, however, and the coarseness of the standstone indicates very swift currents and sediment-filled waters. The large size of the *Cyrtospirifers* and the very rounded, streamlined ball shape of the *Camerotoechias* were features that allowed these animals to live in the swift currents where most animals could not live. *Whidbornella* was able to live on the sandy bottom because its shell bore spines, now absent, that stuck in the mud and prevented it from being swept away.



LOCATION. An excellent collecting locality with well-preserved fossils is situated in Fayette County. This locality is one of the very few in Pennsylvania where nearly complete crinoid calices may be collected. The fossils are in an old abandoned quarry on the east side of Chestnut Ridge about 8 miles east of Uniontown along U. S. Route 40. The quarry is not easily observed from the highway because it is several hundred feet north of the highway. A dirt access road across the highway from a private road 1.2 miles east of Summit leads north to the quarry. The fossils are scattered over the floor of the quarry. Many of the layers in the face of the quarry are fossiliferous also.

FOSSILS. The fossils at this locality are, in most cases, weathered free of the limestone and thus can be collected whole. In addition to excellently preserved specimens of brachiopods, specimens of the stem, calyx and ambulacra of crinoids may be collected. The calyx specimens may bear a little of the lower part of the ambulacra but usually the "arms" of the crinoids are separated. Specimens of the ambulacra with the delicate pinnules still attached are commonly found. Fragmental specimens of the class Echinoidea are also found. These are the spines and the plates to which the spine is attached. The fossils listed below are illustrated in Plates 8 and 9.

BRACHIOPODS
- *Composita*
- *Dielasma*
- *Diaphragmus*
- *Orthotetes*
- *Rhipidomella*
- *Spirifer*

PELECYPODS
- *Allorisma*
- *Nucula*
- *Nuculana*
- *Pinna*

CEPHALOPOD
- *Endolobus*

CRINOIDS
- *Eupachycrinus*
- Columnals
- Ambulacra
- Calices

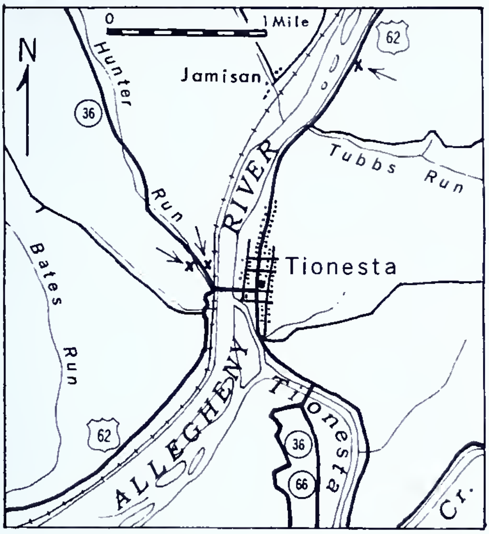
ECHINOIDS
- Plates and spines

BRYOZOA
- *Fenestrellina*
- *Polypora*
- *Rhombopora*

TRILOBITES
- *Kaskia*

GEOLOGY. The limestone exposed in the Chestnut Ridge quarry is called the Greenbrier limestone. It is the same limestone that is exposed in the Somerset County locality but it differs from the latter in that it is a more pure limestone with less shale. The Greenbrier was deposited 340 million years ago during the Mississippian Period in a marine sea that covered only the southwestern counties of Pennsylvania. North of this area the Greenbrier does not exist and in its place are red shales and sandstones of the Mauch Chunk Formation. These were being deposited in streams and rivers on land while the Greenbrier limestone was being deposited in the marine sea.

LOCALITY 25—FOREST COUNTY



LOCATION. A few exposures in the vicinity of Tionesta along the valley of the Allegheny River contain fossils. Many of the rocks are unfossiliferous but occasional thin layers may be filled with fossils. One of the best places to collect fossils in Forest County is in the rocks exposed near the west end of the bridge which crosses the Allegheny River at Tionesta. The bridge is the junction of U. S. Route 62 and Pa. Route 36. Rocks are exposed north of the western part of the bridge and in the cuts on the highway. The best fossils, however, are found in the many loose blocks that line the banks of Hunter Run from the bridge northward. Other exposures and the creek banks north along Pa. Route 36 may also be examined for fossiliferous rocks. The road cut banks about 1.5 miles north of Tionesta on the east side of U. S. Route 62 also may be examined for occasional thin layers of fossils. The long road cut on the east side of U. S. Route 62 0.5 mile south of West Hickory and about 5.5 miles north of Tionesta is another place to collect fossils from similar rocks. Patience must be exercised in examining these road outcrops because much of the rock is unfossiliferous. The fossiliferous layers may be only one to a few inches in thickness and may be difficult to locate.

FOSSILS. Brachiopods and pelecypods are the commonest fossils to be found in these rocks. These, however, are not abundant because much of the rock of the area does not contain fossils. The fossils collected from the area are listed below and are illustrated in Plates 6, 7 and 8.

BRACHIOPODS
- *Camerotoechia*
- *Cyrtospirifer*

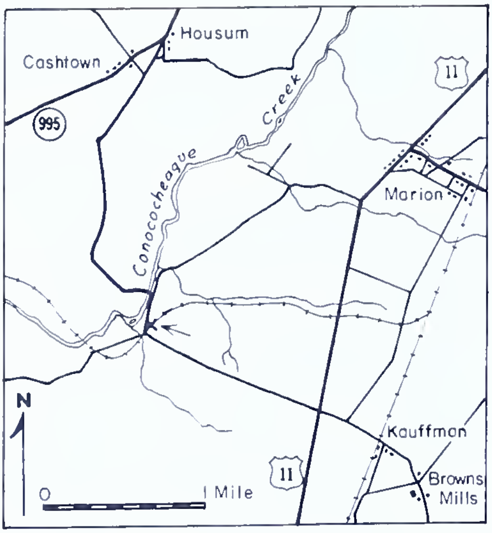
PELECYPODS
- *Edmondia*
- *Leiopteria*
- *Leptodesma*

CRINOID
- Columnals

BRYOZOAN
- *Batostomella*

GEOLOGY. The rock layers exposed along the valley of the Allegheny River near Tionesta are called the Oswayo Formation. These rocks were deposited at the end of the Devonian Period about 350 million years ago. The rocks are composed of shale, siltstone and sandstone. Occasional thin layers contain fossils. These thin layers of fossils represent periods of short duration when waters that were saline enough to support marine life flooded this region. Most of the time the water in which the rocks were being deposited was too fresh for marine life, thus no fossils are found in these rocks.

LOCALITY 26—FRANKLIN COUNTY



LOCATION. The cut along the little-used Pennsylvania railroad spur to Mercersburg just west of Kaufman is a good locality for collecting Middle Ordovician Period fossils. Exposures on the railroad are both north and south of a paved county road that crosses U. S. Route 11 at Kaufman 7.5 miles south of Chambersburg. The railroad cut is 1.2 miles west of U. S. Route 11. The exposure along the railroad south of the county road is limited to a few feet of rock but these rocks contain the unusual ball cystoid *Echinosphaerites.* It should be possible to find the same layers in the field to the southeast of the railroad. The exposure north of the county road extends along the railroad for nearly 1000 feet. Fossils are found throughout the outcrop in loose blocks and in some fossiliferous layers. Many of the limestone layers, however, are completely unfossiliferous.

FOSSILS. Complete specimens of cystoids, one of the more rare fossils groups, are found at this locality. The genus *Echinosphaerites* found at this locality is shaped like and looks like a small round ball. The numerous (800 or more) pentagonal and hexagonal plates that make up the theca (body) of the animal are covered by a very thin calcareous "skin" that hides the suture between the thecal plates. Weathered specimens and specimens in which some of the plates are missing show the shape of the individual plates. Separated calyx plates of the crinoid genus *Carabocrinus* which are characterized by a distinctive surficial design are also found at this locality. The fossils listed below are illustrated in Plates 1, 2 and 3.

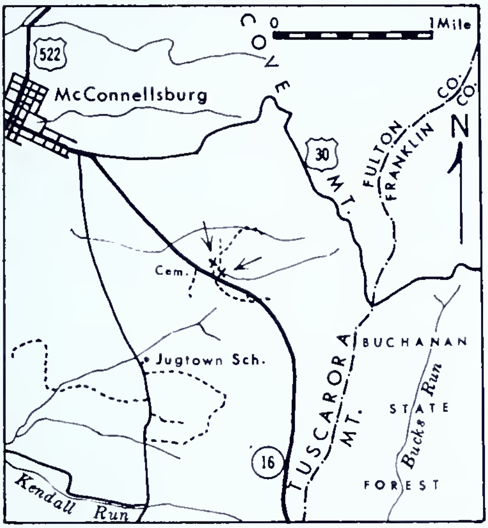
Brachiopods
- *Dalmanella*
- *Leptaena*
- *Rafinesquina*
- *Sowerbyella*

Trilobites
- *Bumastus*
- *Calyptaulax*

Crinoids
- *Carabocrinus*
- Columnals

Cystoid
- *Echinosphaerites*

GEOLOGY. The rocks exposed at the railroad cut west of Kaufman belong to the Mercersburg and Shippensburg Formations of Middle Ordovician Age (450 million years old). Both of the formations are composed of limestone. Many of the layers contain few if any fossils while others contain many fossils. The origin of the limestone beds without fossils is not completely understood. Many of these unfossiliferous layers of calcium carbonate may have been precipitated directly from the sea water. Many of them may also be composed of extremely small particles of fragments of animals, too small to be recognized.

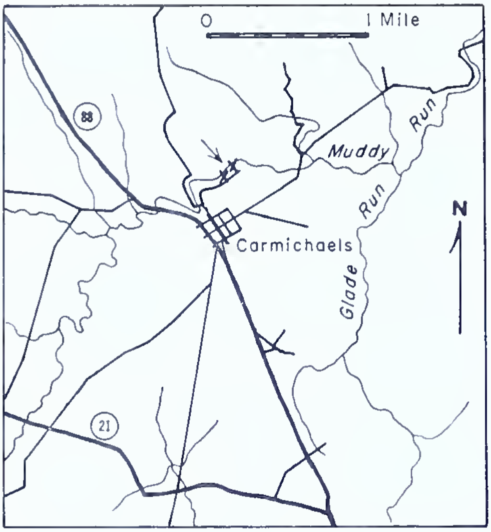


LOCATION. Ordovician Period graptolites may be collected from black shales in a small road cut and borrow pit about 1.5 miles southeast of McConnellsburg on the west flank of Tuscarora Mountain. The road exposure is along a dirt road about 100 feet north of Pa. Route 16. This dirt road leads north off the main highway at a point 1.05 miles southeast of the intersection of U. S. Route 30 and Route 16 in McConnellsburg. Only a few feet of rock are exposed on the south side of the road for a distance of 20 feet. About 200 feet northwest of the road exposure, on the north side of the dirt road, is a small borrow pit somewhat overgrown with brush. The fossiliferous black shales are exposed in the borrow pit also.

FOSSILS. Only two kinds of fossils are found at this locality. The phylum Brachiopoda is represented by the inarticulate genus *Leptobolus*. This is a small, teardrop-shaped animal that is similar in outline to most other inarticulate brachiopod genera. The shells of inarticulate brachiopods originally were composed of chitin and phosphate and the animals were adapted to live in environments in which most animals could not live. The graptolites are represented by two genera, *Diplograptus* and *Climacograptus*. Both of these are common in the black shales while *Leptobolus* is rare. Discovery of the fossils may be somewhat difficult inasmuch as both the rock and the fossils are very black. The fossils discussed here are illustrated in Plates 2 and 3.

GEOLOGY. The rock exposed at this locality belongs to the Reedsville Formation. It was deposited during the Late Ordovician Period about 435 million years ago. Because of their distinctive color, the black shales are called the Antes Member of the Reedsville. Black shales are deposited only under very unusual conditions. They are found today in bodies of water such as the Black Sea where the water at the sea bottom is stagnant. Almost no animals can live in stagnant water, thus we find in these rocks only a few fossils such as the graptolites which floated in on the surface of the sea and then died, or the peculiar inarticulate brachiopods that could live in water where oxygen was nearly absent. Thus, the black shales of the Reedsville indicate a time during the Late Ordovician Period when the sea bottom in this part of Pennsylvania had stagnant waters.

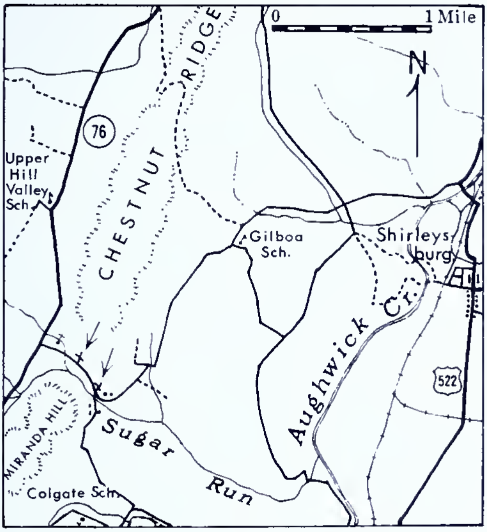
LOCALITY 28—GREENE COUNTY



LOCATION. Late Pennsylvanian Period plant fossils may be collected in a stream exposure about 12 miles east of Waynesburg. The fossiliferous shales are found along the south bank of Muddy Run 0.4 mile north of the center of the Borough of Carmichaels and 0.5 mile east of the Pa. Route 88 bridge over Muddy Run. The Waynesburg coal and its overlying fossiliferous shales outcrop just east of a small falls. Access to the outcrop is difficult because of the steep banks of Muddy Run. The easiest access to the exposure is to follow Market Street in Carmichaels north to the last cross street before crossing Muddy Run. Turn right onto the street next to the cemetery and follow it until reaching a group of buildings housing deep-mine air pumps. Several foot paths lead north over the high bank down to the stream.

FOSSILS. The only fossils found at this locality are those of the seed fern genus *Neuropteris* and the true fern genus *Pecopteris.* The lack of different genera of plants is made up for by the abundance of specimens. The fossils are found in the foot or so of shale that directly overlies the coal which is exposed at a few places along the creek. Several drifts have been driven into the coal so portions of the bank have fallen in and thus a great deal of the fossiliferous shale is loose as rubble. The pinnae of *Neuropteris* are very abundant and measure up to three inches in length. The specimens of *Pecopteris* are much smaller. Fragments and pieces of stems of plants may also be found in some of the sandy layers above the shale. One three-foot long plant stem with branches was collected here. Illustrations of the plant genera are in Plate 10.

GEOLOGY. The shale which overlies the Waynesburg coal is called the Cassville shale. It was deposited near the end of the Pennsylvanian Period about 285 million years ago. It is called the Cassville shale because at Cassville, West Virginia the same shale contains a large and very well preserved assemblage of plant fossils, many more genera than are found at Carmichaels. The shale represents a time of prolific fern and seed fern growth in nearby swamps that existed at the time of deposition of the shale. The rapid covering of the plant fragments with the fine mud that hardened into the shale preserved the fossils with great fidelity.



LOCATION. A long road cut about seven miles south of Mt. Union is a good locality for collecting Lower Devonian Period fossils from several diverse rock types. The exposures are on the north side of the county road that leads east of Pa. Route 276 seven miles south of the center of Mt. Union. The county road extends northeastward to connect with U. S. Route 522 just north of the village of Shirleysburg. The outcrop is on the south-facing part of Chestnut Ridge where Sugar Run has cut a narrow valley. The exposure begins near the bridge over Sugar Run and continues intermittently for about 0.3 miles. Limestone and chert are exposed near the stream, calcareous shale about 0.1 mile east of the stream and fossiliferous sandstone is exposed in a small pit on the east side of Chestnut Ridge 500 feet west of the intersection of a township road with the road leading to Shirleysburg.

FOSSILS. Brachiopods are predominant in the rocks exposed at this locality. The fossils are included in the same genera as seen at the Bedford, Mifflin and Snyder County localities except for two genera *Costispirifer* and *Rensselaeria*. These two genera are found in the sandstone at the east end of the exposure as molds. Illustrations of the fossils listed below are found in Plate 4.

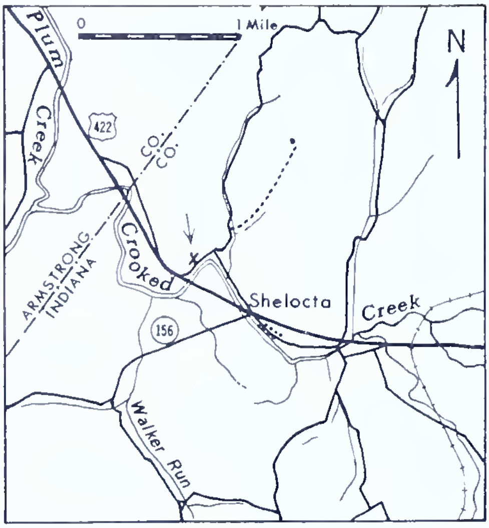
BRACHIOPODS
Atrypina
Costispirifer
Eospirifer
Gypidula
Leptaena
Leptostrophia
Renssellaeria
Rhipidomella

CEPHALOPOD
Michelinoceras

CRINOID
Columnals

GEOLOGY. Several rock units are exposed at this locality. In an abandoned quarry to the south of Muddy Run is the Keyser limestone. The Keyser was deposited during the Late Silurian and Early Devonian Periods. The Keyser is not seen on the road. The road exposures show limestones and shales included in the "Helderberg" formation, which overlies the Keyser. At the east end of the exposure the Ridgeley sandstone outcrops in the small pit. The limestones and shales of the "Helderberg" and the Ridgeley all were deposited in a continuous sequence during early Devonian times. They show by their progressive change in rock type the changes occurring in the early Devonian seas. The limestones were deposited in quiet waters far from shore, the shales were deposited nearer shore from streams emptying mud into the sea. The sandstone probably was a beach or sand bar that was very near the shore line of the early Devonian sea.

LOCALITY 30—INDIANA COUNTY



LOCATION. Fossiliferous rocks are well exposed in western Indiana County near the boundary line between Indiana and Armstrong Counties. The fossiliferous exposure is about 9 miles west of Indiana along the valley of Crooked Creek. The fossils are found in a road cut bank on the west side of a paved road which leads north off U. S. Route 422 0.45 mile west of the junction of the U. S. Highway and Pa. Route 15 at the village of Shelocta. The cut bank extends north along the side road from its junction with U. S. Route 422 for several hundred feet. The road parallels a meander in Crooked Creek. The best fossils to be collected are found in the shales which directly overlie the 1-foot-thick limestone that occurs 10-20 feet above the road level. The banks are not too steep so that these shales can be reached without too much difficulty. Some fossils may also be found in the limestone but these are difficult to extract because of its hardness.

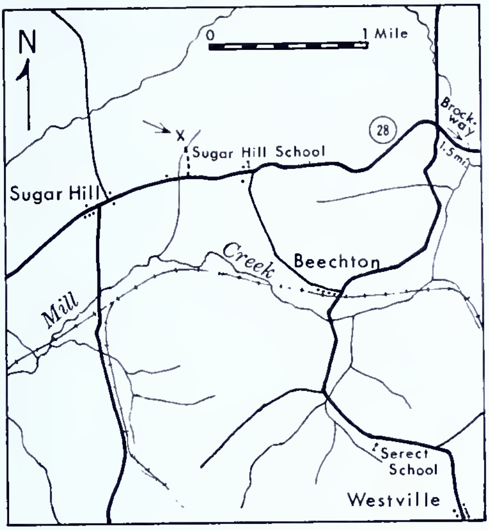
FOSSILS. The fossils to be found most frequently at this locality are small gastropods (snails). These occur in abundance with other fossils. The shells of these animals have been leached so that in many cases the shells consist of a whitish powdery residue of an original calcium carbonate composition. The fossils to be found at this locality are illustrated in Plates 8 and 9.

Brachiopods
  Crurithyris
Coelenterate
  Lophophyllidium

Gastropods
  Ianthinopsis
  Pharkidonatus
  Euomphalus
  Shansiella
  Soleniscus
  Worthenia

Pelecypods
  Nucula
Crinoid
  Columnals

GEOLOGY. The thin limestone bed exposed in the road bank is the Brush Creek Limestone. The shale above this layer is also called Brush Creek. The rock layers were deposited during the Pennsylvanian Period approximately 290 million years ago. During most of the Pennsylvanian period great thicknesses of coal bearing rocks formed. The limestone was deposited in a relatively clear marine sea that occupied this part of Pennsylvania for a short period during the Pennsylvanian Period. After the deposition of limestone the streams entering the sea brought mud to the sea. This mud is now shale above the limestone. Snails, which were adapted to living in this muddy environment, were predominant.



LOCATION. Fossiliferous rocks may be found in many exposures in Jefferson County. A good locality is in the northeastern part of the county near Brockway. The recommended locality is in an operating limestone quarry about 4 miles west of Brockway. The quarry is 0.7 mile northeast of Sugar Hill. The outcrop is reached by following Pa. Route 28 east from Sugar Hill for a distance of 0.6 mile. At this point the quarry company has constructed a haulage road that leads north from the state highway to their crushers and quarry. *Permission must be secured before entering this quarry.* The fossils are found in the limestone which is being quarried and in a zone of heavy iron concentration at the top of the limestone. The best fossils from the limestone are found on the dump pits near the entrance to the quarry. These discarded blocks are weathered and the fossils stand out on the surface of the rock. The iron-rich zone is also a good zone for fossil collecting because, unlike the limestone, it is easily broken apart to get at the fossils.

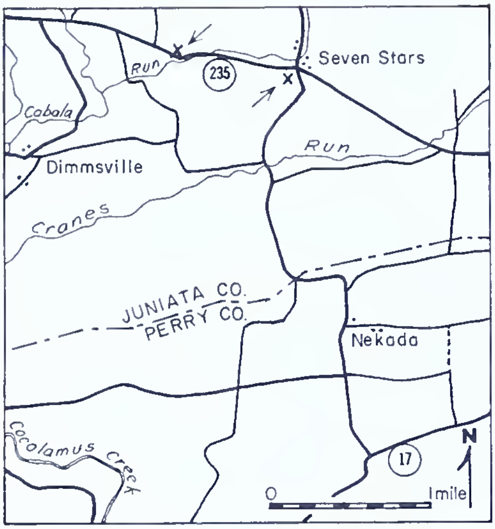
FOSSILS. This locality contains specimens of several brachiopod genera. The fossils collected at this locality are illustrated in Plates 8 and 9. Diligent searching will reveal many more genera than are listed here.

BRACHIOPODS
  Composita
  Hustedia
  Marginifera
  Mesolobus
  Phricidothyris

CRINOID
  Columnals
BRYOZOAN
  Rhombopora

GEOLOGY. The limestone exposed in the quarry is the Vanport limestone. This limestone was deposited during the Pennsylvanian Period about 295 million years ago. This locality also exposes the "Buhrstone ore". This is an iron-rich zone a few inches thick that directly overlies the limestone. Many excellent fossils are in the iron-rich zone. The "Buhrstone ore" represents a short period of time just after the deposition of the limestone when the marine sea waters may have been slightly oversaturated with iron. Due to the very unusual chemical conditions, this iron was deposited on the limestone and replaced some of the limestone. The unusual chemical conditions lasted only a relatively short time before the sea waters withdrew from the area and fresh water stream and river sediments were deposited on top of the iron ore.

LOCALITY 32—JUNIATA COUNTY



LOCATION. The borrow-pit (small quarry) behind the restaurant gas station at Seven Stars and a similar pit less than a mile west of Seven Stars are good localities for collecting large external and internal molds of several pelecypod genera. The localities are: 1. at the southwest corner of the intersection of Pa. Route 235 and a country road at Seven Stars and, 2. 0.75 mile west of the intersection on the north side of Route 235. Route 235 starts at Liverpool on the Susquehanna River where it intersects U. S. Routes 11 and 15 and extends westward to McAlisterville. Consult the map for further directions. Permission should be obtained from the property owners at Seven Stars before attempting to collect. Excellent specimens are scattered throughout the rock at each exposure.

FOSSILS. The Seven Stars locality is noted for the abundance of pelecypod and brachiopod specimens and genera. Some of the largest fossil pelecypods in central Pennsylvania occur here. Gastropods, cephalopods, trilobites, bryozoans and microscopic ostracodes are also present. The original shell material of the fossils has been dissolved, leaving only casts and molds. The fossils listed below are illustrated on Plates 5, 6 and 7.

BRACHIOPODS
- *Camerotoechia*
- *Chonetes*
- *Tropidoleptus*
- *Mucrospirifer*
- *Mediospirifer*

TRILOBITES
- *Phacops*
- *Greenops*

PELECYPODS
- *Nucula*
- *Nuculites*
- *Modiomorpha*
- *Cypricardella*
- *Actinopteria*
- *Leiopteria*
- *Grammysia*

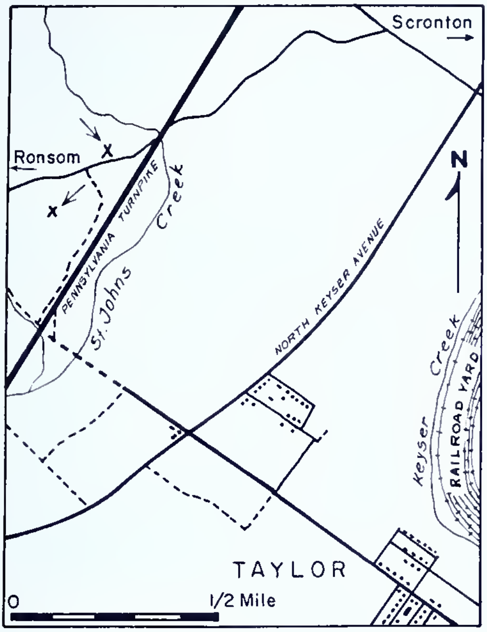
BRYOZOAN
- *Fenestella*

OSTRACOD
- *Ponderodictya*

GASTROPODS
- *Bembexia*
- *Loxonema*
- *Tropidodiscus*
- *Crenistriella*

CEPHALOPOD
- *Michelinoceras*

GEOLOGY. The rock exposed in the borrow-pit is the upper part of the Devonian Mahantango Formation and is about 370 million years old. The rock is a claystone, its particles are microscopic (clay-size) the same as in shale, but it lacks the very thin layers characteristic of shale. The rock is very weathered and easily breaks into small fragments. Similar exposures in rocks of the Mahantango Formation in other counties of Pennsylvania also contain many of these fossils and they give evidence of a period of time near the middle of the Devonian Period when abundant marine life flourished on the sea bottom.

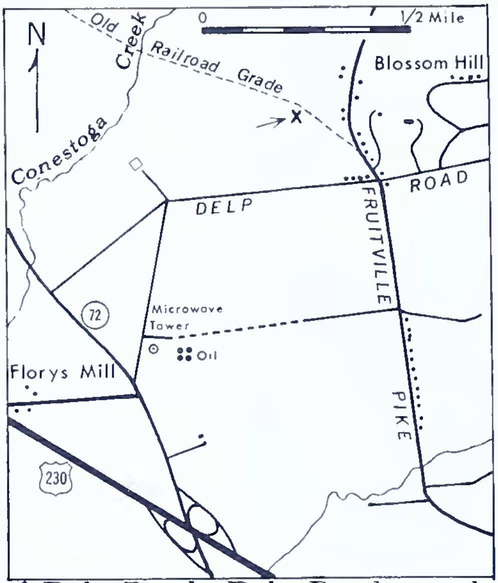


LOCATION. As with many of the counties in Pennsylvania famous for their coal-bearing rocks, Lackawanna County lacks rocks formed in marine seas and thus lacks marine fossils. Plant fossils occur, however, wherever coal is mined, particularly in the shales directly over the coal beds. Exposures of the coals and overlying shales appear and disappear very rapidly because of the intensive strip mining. It is difficult to select any given strip mine for collecting because the exposure may be covered over by further stripping operations within a short time. Many of the dump piles from stripping and subsurface mining operations have good fossils. The locality recommended for Lackawanna County is one of these. North of the Pennsylvania Turnpike-Northeast Extension on the lower slope of Bald Mountain about two miles west of Scranton are several abandoned strip mines. To get to these stripped areas turn west from Keyser Avenue 1.25 miles due north of Taylor and follow the road toward Ransom until crossing the bridge over the turnpike. Stripped areas are to the north and south of the road. A dump pile of fossiliferous shale may be found near an abandoned loading platform south of the Ransom road. The area is very much overgrown with small trees and brush and is cut up with several small roads used in the mining operations.

FOSSILS. Plant fossils associated with the coal beds are the only fossils found here. The genera most commonly found are the leaflets of the fern genera *Pecopteris* and the seed fern genus *Neuropteris.* In addition specimens of portions of the trunks of the "seal" and "scale" trees *Sigillaria* and *Lepidodendron* are also found. Careful search of the area may turn up many fine specimens of trees and ferns. Illustrations of the fossils are in Plate 10.

GEOLOGY. The rocks from which the dump piles have been derived belong to the Llewellyn Formation which was deposited during the Pennsylvanian Period about 290 million years ago. The rocks were deposited in an area somewhat like the swamps of modern Florida where coal deposits are now forming. The coals were formed in swamps and the shales and sandstones were deposited in the rivers and streams that threaded their way through the swampy region. Now the coal, shale and sandstone are solid rock and have been gently bent into a wide valley.

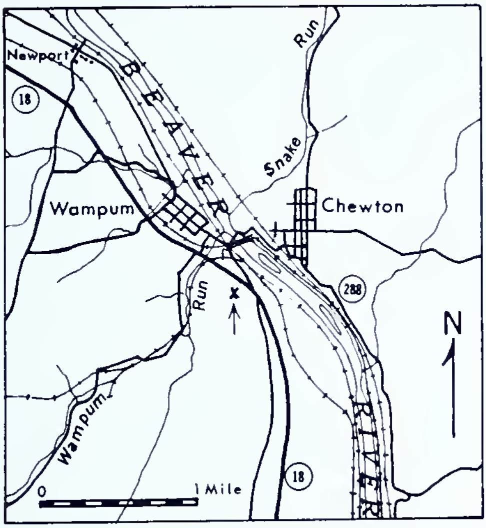
LOCALITY 34—LANCASTER COUNTY



LOCATION. Lancaster County does not contain many fossiliferous rocks. However, one famous locality where Cambrian Period fossils may be colected is located in the County. This locality is nearly four miles north of the center of Lancaster. The fossils are found in an abandoned quarry about 50 feet to the south of an old railroad grade. The tracks and ties are no longer present and the grade is used by local farmers as a road. The quarry is 500 feet west of the Fruitville Pike and 600 feet north of Delp Road. Delp Road may be reached by following Pa. Route 72 north from its intersection with U. S. Route 230 for a distance of 0.35 mile. Delp Road bears off to the right near the oil storage tanks. *Permission must be secured from the farmers whose land you must cross to get to the quarry.* This quarry may disappear within a few years due to urban construction which is rapidly proceeding in the area. Fossils are difficult to find in the quarry, but examination of the exposed rock at the west end of the quarry has produced fossils. The same rocks are exposed in a small road cut due southwest of the quarry, where Delp Road crosses the same low ridge. Fossils have been found here also. It is reported by local residents that fossils have been found in similar rocks exposed in the new road cuts of the highway bypass west of Lancaster. These fossils have been found on the east side of the bypass about 75 south of the bridge which carries Harrisburg Avenue over the new road. Other exposures in the immediate neighborhood may also contain fossils.

FOSSILS. The number of specimens and type of fossils are very limited at the Fruitville Pike quarry. Molds of two trilobite genera, *Paedumias* and *Olenellus*, both of which look very much alike, are found in the quarry. Very small conical molds may also be collected. These were formed by a small extinct animal called *Hyolithes* whose exact nature is unknown. It apparently lived on the sea floor with its pointed end stuck in the mud. Impressions of the inarticulate brachiopod *Obolella* are also found in some of these rocks. These fossils are illustrated in Plate 1.

GEOLOGY. The rock exposed in the quarry and on Delps Road is the Kinzers Formation, a shaly siltstone. It was deposited near the beginning of the Cambrian Period approximately 520 million years ago. Few fossils are found because at this time in the earth's history only a few animal groups, such as the trilobites, had shells that could be fossilized.



LOCATION. West of Ellwood City on the west side of the Beaver River fossils may be collected from limestone exposed in abandoned quarries. The quarries are about 0.7 mile south of the center of Wampum on the hillside approximately 500 feet west of Pa. Route 18. Access to the quarries may be attained by climbing the hill from the highway or following one of the access roads that leads west from Pa. Route 18 into the quarries. The quarries follow the contour of the hill and extend for quite some distance. Fossils may be found throughout the limestone. Blocks that have fallen onto the quarry floor are the best places to look because they have been exposed to the elements and are more weathered. Many fossils have been weathered free and can be extracted whole.

FOSSILS. While the smooth-shelled brachiopod *Phricidothyris* is very common at this locality, several genera of gastropods are common also. Excellently preserved specimens of *Euconospira* may be collected. In addition, specimens of very large crinoid stems, up to 1 inch in diameter may be found at this exposure. No specimens have been found of the calyx or ambulacra of the crinoid that lived on top of the very large stem. Illustrations of these and other Vanport fossils are found in Plates 8 and 9.

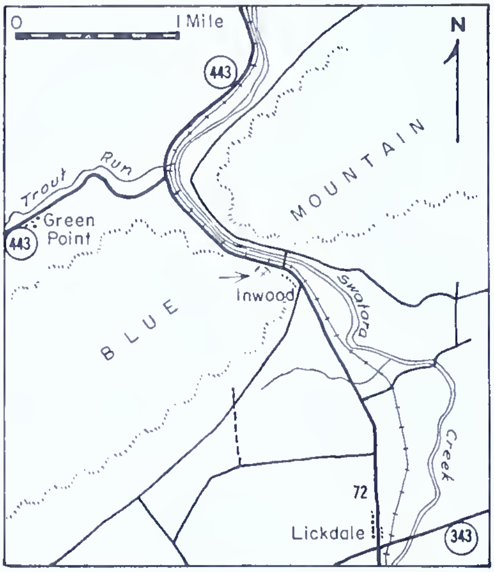
BRACHIOPODS
  Phricidothyris
  Spirifer
CRINOID
  Columnals

GASTROPODS
  Colpites
  Euconospira
  Platyceras
  Worthenia

ECHINOID
  Spines
  Plates
BRYOZOAN
  Fenestella

COELENTERATE
  Lophophyllidium

GEOLOGY. The limestone exposed in the quarries south of Wampum is called the Vanport limestone. It was deposited during the middle of the Pennsylvanian Period about 295 million years ago. The Vanport in this area is thick and is very pure. As a result it has been an important raw material for the cement and the steel industries. The Vanport has been exploited by both the open quarry and underground mine method. The underground mines at Wampum are now abandoned and some are used as storage areas by Civil Defense. The purity of the limestone and its contained fossils indicate that it was deposited in clear marine waters. The Vanport limestone thus represents a time when little mud was entering the marine sea that covered the area. The sharp change to sandstone above the Vanport indicates a rapid change in depositional environment.



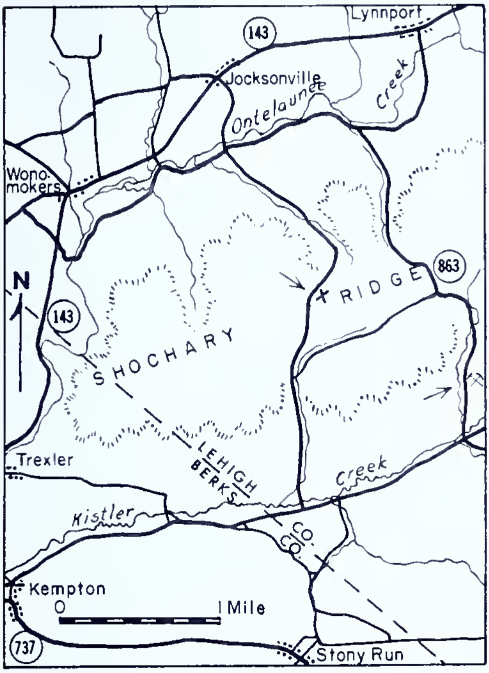
LOCATION. One of the most famous and nationally known fossil collecting localities in Pennsylvania is present in northern Lebanon County along the south side of Blue Mountain. The exposure, known as the Swatara Gap locality, is in an abandoned road-fill quarry on the west side of Pa. Route 72, 1.9 miles north of the town of Lickdale. At this geographic point the highway cuts through Blue Mountain along Swatara Creek. The gap in the mountain is thus called Swatara Gap. The quarry is easily missed but is about 500-600 feet north of the bridge over Swatara Creek. The exposure is on the inward side of a bend in the road. Two or three cars may park in the access road leading back to the quarry. Extreme caution should be exercised by pedestrians or vehicles crossing the highway into the quarry. South-travelling motorists cannot see around the bend.

FOSSILS. All the fossils found at this locality are molds of the original shells. The locality is famous, however, because of the abundance of the trilobite genus *Cryptolithus.* Specimens of the various parts of this animal are easy to find, and nearly complete specimens with cephalon, thorax, and pygidium together are regularly found. Other fossils are also found here including extremely rare specimens of star fish. The fossils listed below are illustrated in Plates, 1, 2, and 3.

- Brachiopods
  - *Dalmanella*
  - *Pholidops*
  - *Rafinesquina*
  - *Sowerbyella*
- Graptolite
  - *Diplograptus*
- Trilobites
  - *Cryptolithus*
  - *Flexicalymene*
- Cephalopod
  - *Michelinoceras*
- Crinoid
  - Columnals
- Gastropod
  - *Sinuites*
- Pelecypod
  - *Lyrodesma*
- Stelleroid
  - *Hallaster*

GEOLOGY. The fossils at Swatara Gap are found in the Martinsburg Formation which was deposited during the Ordovician Period. The fossils are about 440 million years old. As discussed in the Berks County locality most of the Martinsburg rocks are unfossiliferous or contains only a few unusual fossils. The rocks at Swatara Gap were deposited later than most of the Martinsburg Formation in Pennsylvania. The fossils show that the sea was not too deep, food was available and the waters were not too muddy for the animals to exist. This gives evidence of a considerable change in the sea in which the Martinsburg rocks at Swatara Gap were formed as compared to the same body of water in which the Martinsburg rocks of Berks County were formed.

LOCALITY 37—LEHIGH COUNTY



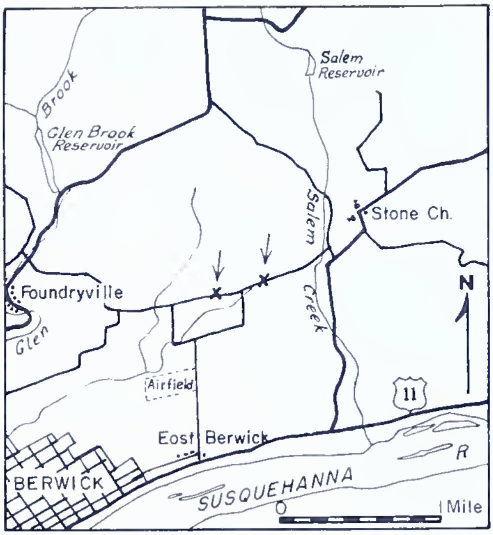
LOCATION. Many exposures of rocks along Shochary Ridge in the western part of Lehigh County contain fossiliferous rocks. Two exposures near the Lehigh-Berks County line are recommended. Both exposures are about three miles northeast of the Village of Kempton. The first exposure is along the east side of the paved county road 1.75 miles south of the intersection of this road and Pa. Route 143 in Jacksonville. The outcrop is about 500 feet south of the farm that is nearly situated at the top of the hill. Fossils may be found in loose blocks and occasionally in place in the cut bank for a distance of 100-200 feet. The second exposure is 1.1 miles southeast of the hilltop outcrop and is a small borrow pit on the east side of Pa. Route 863. It is 0.35 mile north of the intersection of the main highway and the county road paralleling Kistler Creek. Fossils may be found in some of the sandy and silty layers exposed in the pit.

FOSSILS. All of the fossils collected at these localities are molds. None of the original shells have been found. Excepting the ubiquitous crinoid columnals, brachiopods are the only fossil found. Illustration of the fossils listed below are included in Plate 1.

BRACHIOPODS	CRINOID
Dalmanella	Columnals
Hebertella	
Rafinesquina	
Sowerbyella	

GEOLOGY. The sandstone on Shochary Ridge belong to the Shochary Ridge Member of the Martinsburg Formation. These sandstones are different from the usual shaly type of rocks in the Martinsburg. They are composed of coarser sediment and contain fossils of animals that lived in a fairly normal marine environment. The Ordovician sea (see discussion of geology under Berks County) in which the Martinsburg shales were deposited must have changed considerably by the time the Shochary Ridge sandstones were deposited. The sea must have been more shallow and food must have been available for the animals. The currents in the sea probably were still strong because we find only a few brachiopods and few other types of marine life. The sandstones themselves indicate deposition in relatively fast-moving currents.

LOCALITY 38—LUZERNE COUNTY

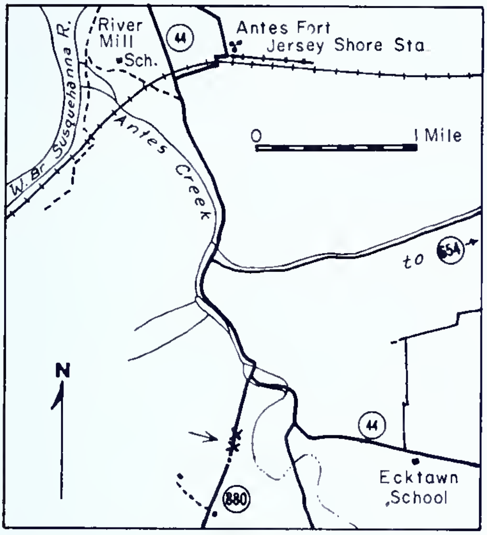


LOCATION. The roadside exposure two miles northeast of Berwick contain rocks from which Middle Devonian Period fossils may be collected. Both exposures are on the township road leading from Foundryville to Stone Church. To gain access to this road follow U. S. Route 11 east to East Berwick and then follow the Airport Road north to the township road. Consult the map for further directions. The westernmost exposure is a small borrow pit on the north side of the road. It lies nearly midway between the two roads that lead off the road past the airport. Fossils are found in bands near the top of the exposure and in loose blocks. The same rocks and fossils are found 0.3 mile east of the borrow pit in a road-cut exposure. The best fossils are found in the borrow-pit exposure.

FOSSILS. As with nearly all Middle Devonian Period fossil localities in Pennsylvania, brachiopods are the most common fossil found. In addition to these, however, the locality contains well-preserved specimens of the small "horn" coral *Heterophrentis*. While most of the fossils at this locality are molds of the original shells, some specimens of the "horn" coral still retain their shell material. The fossils listed below are figured in Plates 5, 6 and 7.

- BRACHIOPODS
  - *Athyris*
  - *Chonetes*
  - *Dalmanella*
  - *Mediospirifer*
  - *Mucrospirifer*
  - *Protoleptostrophia*
  - *Tropidoleptus*
  - *Tylothyris*
- BRYOZOA
  - *Fenestella*
  - *Sulcoretopora*
- PELECYPOD
  - *Paleoneilo*
- COELENTERATES
  - *Coenites*
  - *Heterophrentis*
  - *Pleurodictyum*
- TRILOBITE
  - *Phacops*
- CRINOID
  - Columnals

GEOLOGY. The fossiliferous rocks exposed in the two outcroppings belong to the Mahantango Formation of Middle Devonian Age. They were deposited about 380 million years ago. Layering in these exposures is difficult to determine because of the many fractures that incline steeply to the south. These are called cleavage fractures and are readily seen. They obscure the original layering of the rock. Close examination of the fossil layers shows that they incline steeply to the north. The fossiliferous layers show the original layering of the rock. The cleavage was caused by compression of the original rock layers. Movement on the cleavage fractures has distorted many of the fossils considerably. Many of them appear very stretched out or compressed.



LOCATION. Excellently preserved Ordovician fossils are to be found in some of the limestones exposed in Nippenose Valley south of Jersey Shore and Williamsport. Fossils may be collected in a road cut exposure several hundred feet long along Pa. Route 880, 0.4 mile south of the intersection of this route and Pa. Route 44. The exposure is on the west side of the narrow-winding road. Caution should be exercised by those wishing to collect at this exposure. The highway is very narrow and winding and only a few feet of shoulder exists between the pavement and the outcrop. Motorists traveling north on the highway are not able to see people collecting at the exposure because of a sharp bend and rise in the road at the south end of the exposure. Little room exists on the east side of the highway for parking because of a retaining fence. Many of the best fossils are found near the southern end of the outcrop. Some specimens may be picked up from the loose rubble where they have weathered free.

FOSSILS. This locality is remarkable for the occasional large slabs of limestone that are covered by many excellently preserved specimens of the trilobite genus *Cryptolithus* and the brachiopod genus *Rafinesquina.* In addition whole specimens of the small brachiopod *Dalmanella* and the bryozoan *Prasopora* may be obtained. The fossils listed below are illustrated in Plates 1 and 2.

BRACHIOPODS
- *Dalmanella*
- *Plectorthis*
- *Rafinesquina*
- *Sowerbyella*

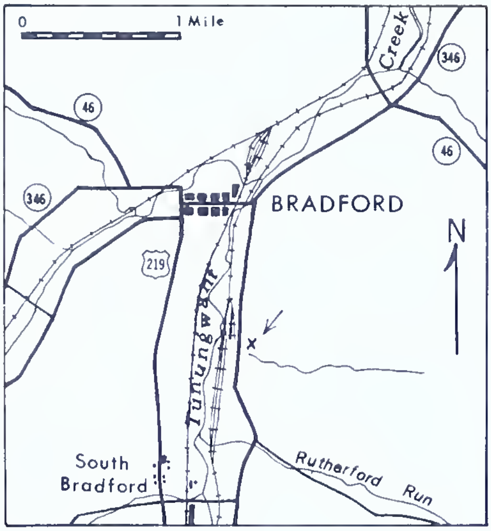
TRILOBITES
- *Cerarus*
- *Cryptolithus*

BRYOZOAN
- *Prasopora*

CRINOID
- Columnals

GEOLOGY. The limestones exposed in the road cut belong to the Coburn and Salona Formations of the Trenton Group. They were deposited during the middle of the Ordovician Period about 445 million years ago. The fossils at this exposure are found concentrated in limestone layers interlayered with shales that contain few fossils. The fossiliferous limestones and nonfossiliferous shales represent a periodic fluctuation in the character of the Ordovician sea that covered this part of Pennsylvania. The shales are indicative of muddy waters without much marine life and the limestones are indicative of clear waters with considerable growth of many animals. The limestone layers without fossils may have been deposited by precipitation of calcium carbonate from the sea water during periods when the sea became oversaturated with this mineral.

LOCALITY 40—McKEAN COUNTY

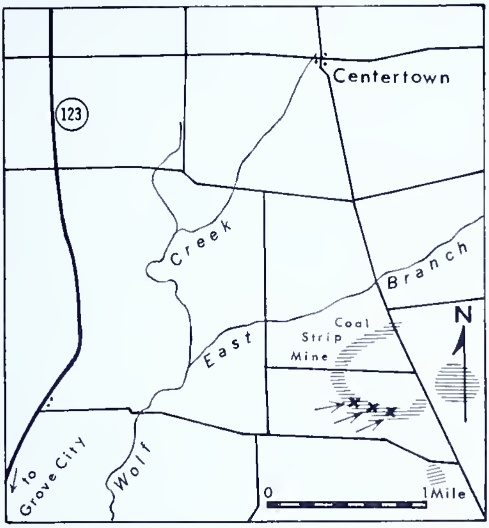


LOCATION. Many of the rocks exposed along the sides of the valley formed by the East Branch of the Tunungwant Creek south of Bradford contain abundant fossils. Nearly everywhere in this area where shale or stone quarries have been operated one can find fossils. One of these quarries, now operated occasionally by the township for road fill, is on the east side of High Street in the city of Bradford. The outcrop extends southward along the hill to the city line, 0.9 mile south of the intersection of High and Main Streets. Nearly all the blocks which have fallen into the quarry contain hundreds of specimens. Some of the shale quarries south along U. S. Route 219 near Lewis Run, six miles south of Bradford, also contain rocks with many fossils.

FOSSILS. Many thousands of fossils may be collected in the exposure at Bradford. Almost all of them are exterior and interior molds of one genus of brachiopod, the genus *Cyrtospirifer.* Some of the blocks of rock are unweathered except for an outer few inches. Splitting these rocks reveals specimens of the brachiopods with the shell material still intact. The unweathered rock is difficult to break because the calcium carbonate of the shells acts as a cement. Specimens of the brachiopod genus *Camerotoechia* are also found as are occasional impressions of crinoid columnals. The fossils found at this locality are illustrated on Plate 7.

GEOLOGY. The shales and sandstones exposed in the quarries at Bradford belong to the Conneaut Group. They were deposited near the end of the Devonian Period about 350 million years ago. The extreme abundance of only two genera of brachiopods and the almost total absence of other fossils is puzzling. The shaly, silty and sandy type of rock exposed in the quarry indicates swift currents and muddy waters in the Devonian sea that deposited them. The different rock layers also indicate rapid changes in deposition from mud to sand. The particular brachiopod genus must have been well adapted to living in this environment which almost entirely excluded other animals. The abundance of specimens suggests that the genus *Cyrtospirifer* lived much as some of our living oysters do with thousands of individuals all living very close together.

LOCALITY 41—MERCER COUNTY



LOCATION. The abandoned coal strip mine 3.5 miles northwest of Grove City is a good site for collecting fossils from a marine limestone. The exposure is two miles west of the intersection of a township road and Pa. Route 173. This intersection is 2.5 miles north of Grove City. The strip pit is over one mile in length and curves around a hill in a half moon shape. The fossiliferous limestone is well exposed in the high wall in the southern part of the strip mine. The pit may be approached from several roads, the one that extends east from Perrys Corners or the one that extends south from Centertown. Fossils may be found in many of the loose limestone blocks that lie on the dump piles surrounding the southern part of the strip mine. These blocks have had a chance to weather more than the limestone in the high wall and thus fossils are easier to collect from them. The limestone exposed in the high wall of the strip mine is difficult and dangerous to reach because of the steepness of the wall.

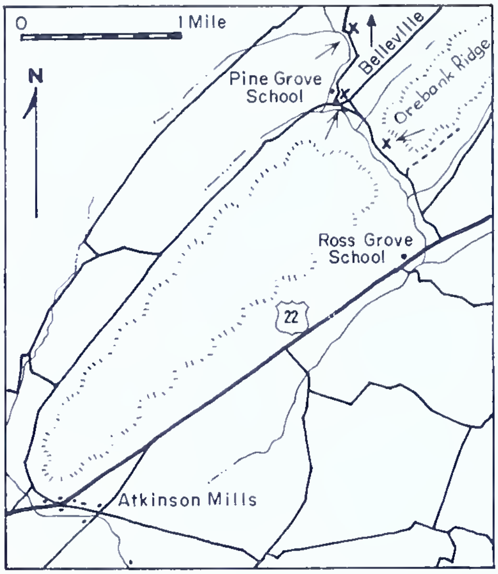
FOSSILS. In addition to the usual fossils the very tiny fossil protozoan *Fusinella* (family Fusulinidae) may be collected in these rocks. These are usually recognized where part of the shell has worn away and the intricate internal network of chambers is revealed. A hand lens would be very useful at this exposure to search for these fossils. The fossils listed below are illustrated in Plates 8 and 9.

BRACHIOPODS
  Phricidothyris
  Spirifer
COELENTERATE
  Lophophyllidium

BRYOZOA
  Rhombopora
  Septopora
GASTROPOD
  Shansiella

FORAMINIFERA
  Fusinella
ECHINOID
  Spines and plates
CRINOID
  Columnals

GEOLOGY. The limestone exposed in the high wall of the strip pit is the Vanport limestone. It was deposited during the Pennsylvanian Period about 300 million years ago. The limestone is very hard and is a "pure" limestone because it is almost entirely made up of the mineral calcium carbonate. The Vanport has only a small percentage of clay in its composition. The lack of clay and other contaminants indicates that the sea water in which the limestone was deposited was clear and not muddy. The Vanport limestone represents a short span of time during the Pennsylvanian Period in which this part of the Commonwealth was covered by a clear marine sea rather than swamps and lakes as was the case during most of the Period.



LOCATION. Several localities, all close together, in the southwestern part of Mifflin County may be visited to collect fossils from Early Devonian Period rocks. The localities are approximately nine miles northeast of Mount Union and two miles southwest of McVeytown. The exposures are all located along the county road called the "Belleville Pike." The Belleville Pike leads north from U. S. Routes 22 and 522 2.5 miles south of the center of McVeytown. The first exposure is a road cut about 300 feet long on the north side of the road 0.7 miles northwest of U. S. Route 22. The second exposure is 1.1 miles northwest of U. S. Route 22 and is a small road cut just north of the crossroads. The third exposure is in a low bank on the north side of the road opposite a farm house 1.6 miles northwest of U. S. Route 22. Fossils may be found in scattered weathered blocks all along the road banks and in the exposed layers. A few fossils may be found weathered loose in the soil and rubble.

FOSSILS. Many genera of brachiopods may be found at these localities with the majority of specimens and variety of genera at the first and third exposures. In addition, specimens of corals have been collected at the third exposure. Also, the very large (up to one inch) ostracode genus *Leperditia* may be found at these exposures. The fossils listed below are illustrated in Plates 4 and 5.

BRACHIOPODS
- *Anoplotheca*
- *Atrypa*
- *Camerotoechia*
- *Delthyris*
- *Eatonia*

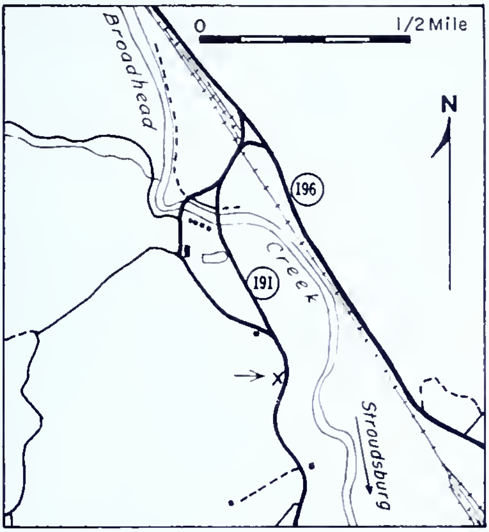
BRYOZOA
- *Monotrypa*
- *Eospirifer*
- *Leptaena*
- *Leptostrophia*
- *Meristella*
- *Orbiculoidea*

COELENTERATES
- *Favosites*
- *Streptalasma*

OSTRACODS
- *Leperditia*

CRINOID
- Columnals

GEOLOGY. The several rock formations exposed at the three localities were all deposited during the late Silurian and early Devonian Periods about 405 million years ago. The exposures include rocks of the Keyser and Helderberg Formations. The Keyser is limestone characterized by a lumpy texture. The Helderberg Formation includes limestone, shale and chert. Many of the fossils in this unit have been replaced by silica and thus may be found weathered free of the enclosing rock.



LOCATION. One of the best collecting localities for fossil corals occurs in the east central part of Monroe County. The locality is well known by professional and amateur paleontologists of the state and is called, somewhat inappropriately, "the Centerfield Coral Reef." The collecting locality is 4.25 miles north of Stroudsburg on Pa. Route 191 on the west side of the road in a large bank. The exposure is 0.65 mile south of the intersection of Pa. Routes 191 and 447. Fossils may be found at the locality in many of the rubble blocks at the base of the cut and all through the exposure itself. Vehicles may park on the wide shoulder east of the highway. Pedestrians should exercise caution at this exposure because south traveling motorists cannot see around the bend in the road at the north end of the cut. Ample space is available for walking along the west side of the road.

FOSSILS. The many specimens of "horn" corals are the most important fossils to be found at this exposure. Horn corals are not common in most of Pennsylvania's fossiliferous rocks. Both molds of the corals and some specimens with original shell material may be found here. Illustrations of the fossils are in Plates 5, 6 and 7.

Coelenterates
- *Coenites*
- *Favosites*
- *Heliophyllum*
- *Heterophrentis*
- *Zonophyllum*

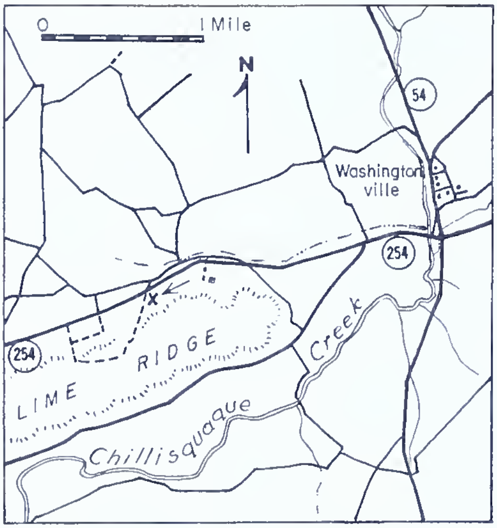
Bryozoa
- *Fenestella*
- *Taeniopora*

Brachiopods
- *Ambocoelia*
- *Athyris*
- *Chonetes*
- *Douvillina*
- *Elthya*
- *Leiorhynchus*
- *Mediospirifer*
- *Mucrospirifer*
- *Protoleptostrophia*
- *Rhipidomella*
- *Schuchertella*

Trilobite
- *Phacops*

GEOLOGY. The fossiliferous exposure is part of the Mahantango Formation which was deposited during the Devonian Period about 390 million years ago. It is not a reef but is properly called a biostrome, which is a layered deposit with abundant fossils. A reef is characterized by a mounded or lens shaped mass of corals. The Monroe County coral locality is layered and not mounded, and thus it is called a biostrome. It represents a period of extreme abundance of coral growth. Apparently, although mud was being deposited here, the "horn" corals could grow fast enough to keep from being totally buried in the mud. They grew with the small end downward. The water must have been relatively clear, however, for the brachiopods and other animals to live.

LOCALITY 44—MONTOUR COUNTY



LOCATION. Montour County, which is geographically one of the smallest counties in the Commonwealth, does not lack fossiliferous rocks or good localities. The rocks exposed on Limestone Ridge, about seven miles north of Danville, are very fossiliferous. Several quarries are operated in these limestones and thus, exposures are plentiful. One exposure which is associated with an operating quarry, is on the south side of Pa. Route 254, 1.9 miles west of the junction of Pa. Routes 54 and 254 at Washingtonville. The exposure is a small borrow pit and is just a few feet south of the highway and east of the crushing plant of the quarry. It is not necessary to go into the large quarry to collect fossils. *If you wish to collect from the operating quarry, permission must be secured before entering. This is private property.* The same rocks are exposed in the smaller exposure along the state highway as are exposed in the quarry. The soil has been removed in the area near the small exposure and natural weathering has loosened many of the fossils from the rock so that they may be collected whole. Similar fossils may be collected around the upper rim of the main quarry where the soil has also been removed. This, however, is a much more dangerous place because of the nearby vertical wall of the quarry.

FOSSILS. Brachiopods and corals may be collected at this locality in abundance. The fossils are illustrated in Plates 4 and 5.

BRACHIOPODS
- *Atrypa*
- *Eospirifer*
- *Meristella*
- *Stenochisma*
- *Strophonella*

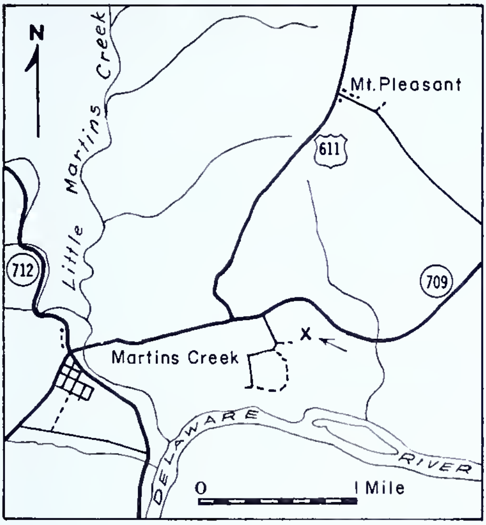
COELENTERATES
- *Cyathophyllum*
- *Favosites*
- *Stromatopora*

CRINOID
- Columnals

CEPHALOPOD
- *Michelinoceras*

BRYOZOA
- *Orthopora*

GEOLOGY. The rocks exposed in the quarry and roadside exposure belong to the Helderberg Formation and were deposited during the Early Devonian Period about 400 million years ago. The limestone at this exposure inclines (dips) to the north at an angle of about 20 degrees and is only part of a series of flexures in the layers of rock west of Washingtonville. The limestones were deposited in a marine body of water that was relatively clear of mud. The sea was warm enough to support growth of corals, which are a semi-tropical and tropical type of animal. The sea must have contained abundant small plant and animal life so that the large animals had food. Present day environments where limestone such as these are being formed are found near Bermuda.



LOCATION. Fossiliferous rocks are difficult to find in Northampton County. Many limestone quarries are present in the county but few of these contain recognizable fossils. One exposure associated with a quarry along the Delaware River north of Easton does contain some fossils. The exposure is near to a small quarry of the Alpha Portland Cement Company 1.5 miles east of Martins Creek. The quarry is not now operated but is used to dump unusable rock from other nearby quarries. When the quarry was originally opened, considerable soil was removed from the hill slope north of the quarry. The rocks exposed on this slope have many fossils. *Permission must be obtained from the Alpha Co. in Martin Creek prior to entry upon this property.* The posted south-leading road 0.2 mile east of the junction of U. S. 611 and Pa. Route 709 provides an approach to the unoperated quarry. The stripped-off area may also be reached by walking about 700 feet south from Pa. Route 79 across the farm fields.

FOSSILS. Bryozoa are the most common fossil found at this locality. Many of the weathered surface of the limestone blocks are covered by the delicate pieces of the genus *Heleopora.* Large masses of the genus *Prasopora* are also common. The fossils listed below are illustrated on Plates 1 and 2.

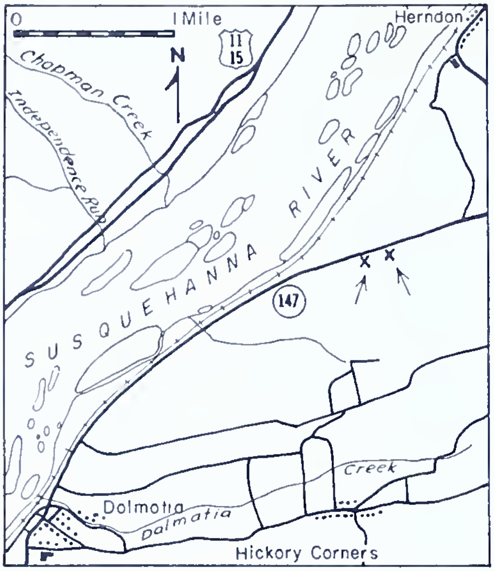
BRYOZOA
- *Heleopora*
- *Prasopora*

CRINOID
- Columnals

BRACHIOPOD
- *Dalmanella*

TRILOBITE
- *Cryptolithus*

GEOLOGY. The limestone exposed in this quarry and field belong to the Jacksonburg Formation. The rocks are about 445 million years old and were deposited during the Ordovician Period. Most exposures of the Jacksonburg do not contain fossils because the rocks have been crushed and broken by cleavage and faults. Thus, many of the fossils have been obliterated. These rocks are of great economic value because of their unique composition. They have just about the right chemical composition to make natural cement. In the early days of the cement industry some of the rock was simply pulverized and used as a naturally setting cement. Now roasting and various other techniques are used to change this limestone into cement. Other materials are also added to the Jacksonburg limestone to bring it to correct composition for cement making.



LOCATION. Southern Northumberland County contains many fossiliferous rocks. Two easily accessible roadside borrow pits north of Dalmatia expose rocks from which fossils may be collected. The two borrow pits are on the south side of Pa. Route 147 2.5 to 2.7 miles north of the center of Dalmatia. The exposure are 1.8 miles west of the junction of Pa. Routes 225 and 147. The two pits are about 500 feet apart. Ample space is available to park vehicles near the borrow pits. Pedestrians should exercise caution while walking along the road because of heavy traffic. Fossils may be found in many of the loose blocks at the base of the road bank as well as in the rock exposure itself.

FOSSILS. All the fossils found here are molds of the original shells; the original shell material has been dissolved. Brachiopods and trilobites are the most common type of fossil of the localities but pelecypods are fairly common also. The fossils are the same genera found in the Carbon, Juniata, Luzerne, Monroe and Schuylkill County localities. The fossils listed below are illustrated in Plates 5, 6 and 7.

BRACHIOPODS
- *Chonetes*
- *Protoleptostrophia*
- *Mucrospirifer*

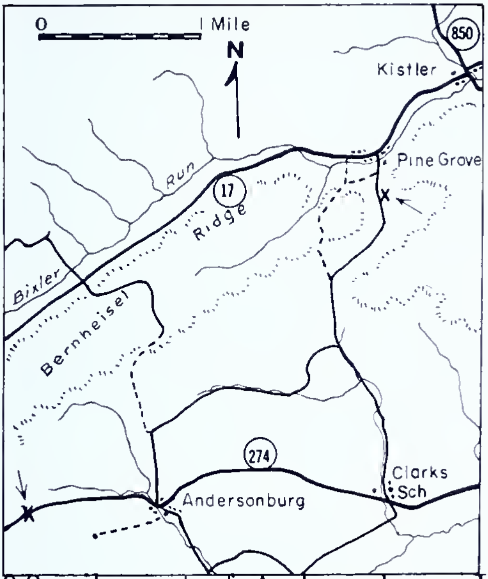
CRINOID
- Columnals

PELECYPODS
- *Liopteria*
- *Paleoneilo*
- *Paracyclas*
- *Orthonota*

TRILOBITES
- *Greenops*
- *Trimerus*

CEPHALOPOD
- *Michelinoceras*

GEOLOGY. The rocks exposed in these Northumberland County borrow pits are part of the Mahantango Formation which is of Middle Devonian Age. They were deposited in a marine sea approximately 370 million years ago. Layering is not easily determined at this locality because the rock is of nearly uniform composition. Examination of the attitude of the fossiliferous portions shows that the layers slope to the north. The very uniform character of the rock is unusual. Most rocks are layered in units of a few inches to a few feet. At those localities there are no noticeable changes in the rock except for the fossils. This indicates that the mud which formed the rock settled from the sea evenly and gradually at a constant rate. There were no sudden changes in the streams bringing mud to the sea or no sudden changes in the currents of the sea itself. Probably the rock formed where only gentle sea currents could bring the mud to its resting place.



LOCATION. Perry County is fortunate in having many fossil collecting localities. The first locality is an excellent exposure on a county road 0.2 miles south of its intersection with Pa. Route 17 0.8 mile west of the intersection of Pa. Routes 850 and 17 in Kistler. Fossils are found in limestone layers all along the exposure. Many are weathered free of the rocks and may be picked up whole. Vehicles may park on the west side of the road. The second exposure is along the south side of Pa. Route 274, 0.8 mile west of Andersonburg. Here sandstone layers are exposed in the road bank. Fossils may be found in the many loose blocks that occur. This locality is recommended because of the unusual fossils found here.

FOSSILS. The first locality contains innumerable fossils, mainly brachiopods. Corals and bryozoans are very abundant in some layers. The fossils listed below and illustrated in Plates 3, 4 and 4 are found at the first locality.

BRACHIOPODS
- *Atrypa*
- *Camerotoechia*
- *Dalmanella*
- *Leptaena*
- *Leptostrophia*
- *Meristella*
- *Orbiculoidea*
- *Pholidops*
- *Rhipidomella*
- *Uncinulus*

OSTRACOD
- *Leperditia*

CORAL
- *Favosites*

ANNELID
- *Spirorbis*

BRYOZOA
- *Batostomella*
- *Fenestella*
- *Orthopora*

GASTROPODS
- *Loxonema*
- *Platystoma*

CEPHALOPOD
- *Michelinoceras*

CRINOID
- Columnals

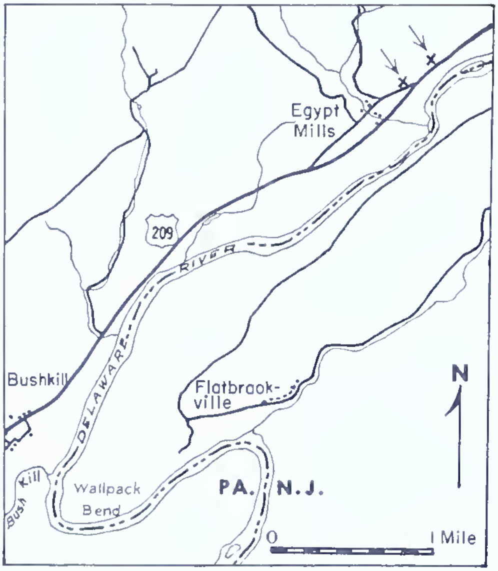
PELECYPODS
- *Actinopteria*
- *Cypricardina*

CRICOCONARID
- *Tentaculites*

The second locality contains specimens of one of the oldest fish in the United States, the genus *Americaspis* which is illustrated in Plate 3. The specimens include nearly complete pieces of the dorsal (upper) head shield of the fish. These fish had no skeleton, but had only a hardened shield which covered the head and extended part way down the back. Scales of the fish are also present. These have a characteristic "fingerprint" pattern on their surface.

GEOLOGY. The rocks exposed at the first locality are the Keyser Formation which was deposited during the late Silurian and early Devonian Periods. The rocks are about 405 million years old. The rocks at the second locality belong to the New Bloomfield Member of the Wills Creek Formation and were deposited during middle Silurian time about 420 million years ago.

LOCALITY 48—PIKE COUNTY



LOCATION. Many of the rock exposures along the north side of the Delaware River in Pike County contain fossils. The most accessible localities are where the county and township have opened pits for road fill. Two of these pits are located about 100 feet north of U. S. Route 209 near the village of Egypt Mills. Egypt Mills is 15 miles northeast of Stroudsburg and eight miles southwest of Dingman's Ferry. The road-fill borrow pits are to the north of the old highway, 0.3 and 0.5 mile east of Egypt Mills. Access to these pits has been provided by haulage roads that join with the main highway. Vehicles can park with ease. The slopes of the pit are very steep and all fossil material has been collected as loose blocks at the base of the slope. Bedrock outcrop is not easily examined because it occurs only near the tops of the slopes.

FOSSILS. Only molds of fossils can be found at this locality. Brachiopods, trilobites and the very rare and unusual fossil *Conularia* have been collected in these pits. The fossils listed below are illustrated in Plates 5, 6 and 7.

Brachiopods
- *Ambocoelia*
- *Chonetes*
- *Mucrospirifer*
- *Tropidoleptus*

Trilobite
- *Phacops*

Pelecypod
- *Paleoneilo*

Gastropod
- *Bembexia*

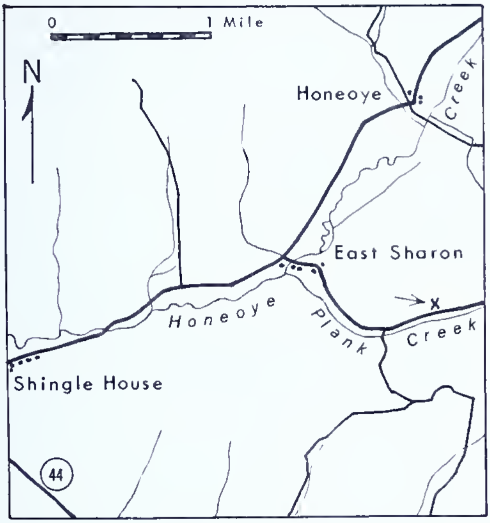
Crinoid
- Columnals

Coelenterate
- *Conularia*

Conularia is a genus belonging to the Phylum Coelenterata; thus, it is related to the corals. It is not a coral, however, but one of the earliest evolved forms of a medusa, which is one of the two main life forms of the coelenterate phylum. The conularids probably swam or floated in the water with the smaller end upward. Tentacles hung down from the large end. Thus, in life habit they lived much as living medusa (jelly fish) do.

GEOLOGY. The rock exposed high on the slope is the Mahantango Formation. It was deposited during the Middle of the Devonian Period about 375 million years ago. The fossils found here are similar to the ones at the Juniata, Monroe and Schuylkill County localities. Here, however, the fossils are not as abundant. The rock is also somewhat more silty and sandy which suggests that these rocks were deposited closer to the ancient shore line where the living conditions were suitable for fewer animals.

LOCALITY 49—POTTER COUNTY



LOCATION. Near the New York-Pennsylvania State boundary line in Potter County some of the Late Devonian Period sandstones contain marine fossils. Exposures along the township road about three miles east of Shinglehouse are recommended for collectors. The collecting area is about 15 miles northwest of Coudersport. Access to the collecting site is achieved by following Pa. Route 44 to Shinglehouse and then following the paved county road east from Shinglehouse along Honeoye Creek. At East Sharon, 2.3 miles east of Shinglehouse, turn right (south) onto the paved road. The exposure is 1.1 miles southeast of East Sharon on the north side of the road. Other exposures on nearby roads may also contain fossiliferous layers.

FOSSILS. Brachiopods and bryozoa are the most common fossils in these rocks, but these fossils are not very abundant. All the specimens are molds of the original shells. None of the shell material except for the bony scales of fish remain. The fish scales are recognized by their white color which is outstanding in the rusty-brown-colored rock. The fish scales appear porous and composed of lustrous material if viewed under high magnification. The fossils listed below are illustrated in Plates 5, 6 and 7.

BRACHIOPODS
- *Camerotoechia*
- *Cyrtospirifer*
- *Whidbornella*

CRINOID
- Columnals

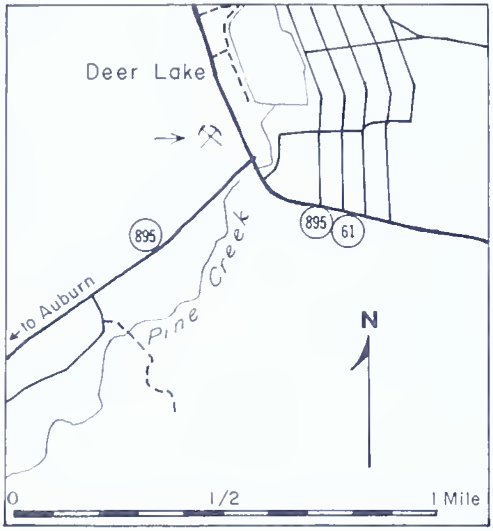
OSTEICHTHYES
- "Fish scales"

PELECYPOD
- *Leptodesma*

BRYOZOA
- *Orthopora*

GEOLOGY. The rocks exposed along Honeoye Creek and its tributaries belong to the Conneaut Group. They were deposited near the end of the Devonian Period about 360 million years ago. The rocks at the locality are composed of brownish sandstone and conglomerate. The presence of the two dissimilar rock types, particularly when associated with fossils, is unusual. The sandstone was probably deposited by swift-moving streams emptying into a marine sea. The presence of the fossils indicates that the sea was marine. The same currents in the streams could not have been carrying the quartz pebbles because the pebbles are large and much faster water would be required to move them. The thickness of the quartz pebble layers indicates that very fast currents must have occurred for short periods of time. Perhaps sudden rainstorms or spring season floods carried the pebbles into the sea where the fossils were living and the sand was being deposited. After the very fast currents ceased the normal stream flow continued and more sand was deposited.

LOCALITY 50—SCHUYLKILL COUNTY



LOCATION. The anthracite region of Schuylkill County is mainly underlain by non-marine rocks. Some of these rocks, particularly near current coal-stripping mines, contain excellent specimens of plant fossils. Exposures such as these disappear quickly due to the mining. Southern Schuylkill County contains fossiliferous rock of marine origin. The recommended locality for collecting is in these marine rocks. The exposure is an abandoned borrow pit 11 miles south of Pottsville. The borrow pit is on the west side of Pa. Route 61 about 200 feet north of the junction of Pa. Routes 895 and 61 in the village of Deer Lake. Fossils are found throughout the pit and particularly along its southern end. The exposures along the main highway south to the road junction and west along Pa. Route 895 to the end of the exposure should also contain fossils. The borrow pit is owned by the proprietors of the restaurant on the east side of the highway from the pit. They have given permission for interested collectors to visit this locality.

FOSSILS. This borrow pit is noted for the variety of pelecypods that occur in its rocks. In addition, specimens of the rare coelenterate *Conularia*, discussed under the Pike County locality, are to be found. The fossils listed below are illustrated in Plates 5, 6 and 7.

Brachiopods
- *Chonetes*
- *Mucrospirifer*
- *Orbiculoidea*

Crinoid
- Columnals

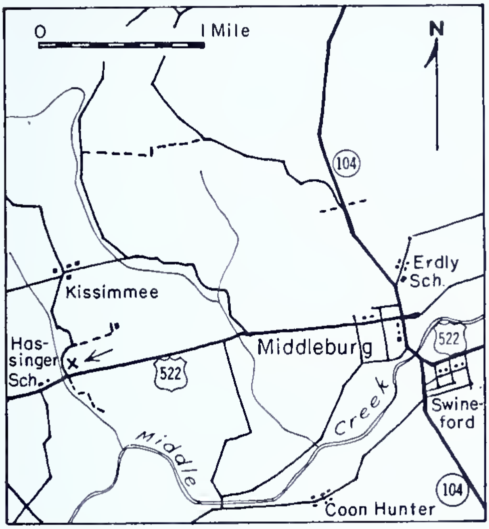
Pelecypods
- *Grammysia*
- *Leptodesma*
- *Liopteria*
- *Modiomorpha*
- *Nuculites*
- *Orthonota*
- *Paleoneilo*

Trilobite
- *Trimerus*

Coelenterate
- *Conularia*

GEOLOGY. The rocks exposed at the Deer Lake borrow pit belong to the Mahantango Formation. They were deposited during the Devonian Period approximately 370 million years ago. This locality and the one in Juniata County are similar in that they both contain many pelecypod genera. The conditions for growth of clams must have been just right at these localities, and, as a result, we have a fossilized remnant of something like our living "oyster" beds. The sea waters must have been clear enough at times to allow these animals to flourish. The shaly character of the rock, however, indicates that considerable mud was being deposited in this sea.

LOCALITY 51—SNYDER COUNTY



LOCATION. An excellent exposure of Late Silurian and Early Devonian rocks is present in central Snyder County. Here many fossils may be collected. The exposure is along the eastern side of a paved county road which intersects U. S. Route 522 2.1 miles west of the center of Middleburg. The outcrop starts in a small quarry a few feet north of an abandoned lime kiln which is just north of U. S. Route 522 and continues north along the county road for several hundred feet. The road banks have recently been scraped so that the rock layers are well exposed. Weathering of the rock layers has loosened many of the fossils so that some may be collected whole.

FOSSILS. Many specimens of crinoid columnals, brachiopods, corals and the coelenterate *Stromatopora* may be collected at this locality. Plates 4 and 5 illustrate the fossils listed below.

BRACHIOPODS
- *Anoplotheca*
- *Atrypa*
- *Dalmanella*
- *Eospirifer*
- *Gypidula*
- *Leptaena*
- *Meristella*
- *Leptostrophia*
- *Strophonella*

COELENTERATES
- *Cyathophyllum*
- *Favosites*
- *Stromatopora*

BRYOZOA
- *Orthopora*

CEPHALOPOD
- *Michelinoceras*

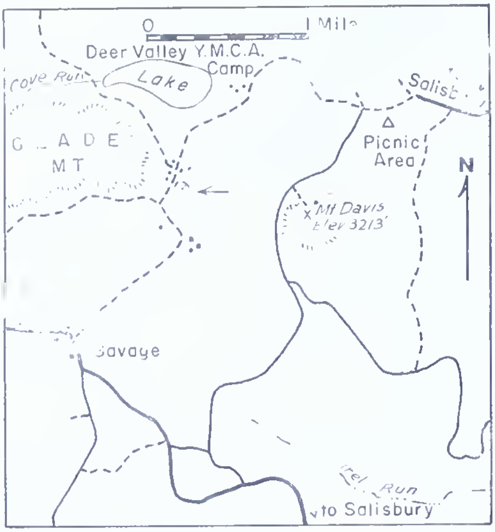
GASTROPOD
- *Platyceras*

CRINOID
- Columnals

GEOLOGY. The rocks exposed at the Snyder County locality are included in the Keyser, Helderberg and Oriskany Formations. They were deposited during the latter part of the Silurian Period and the early part of the Devonian Period. The Keyser Formation is located at the southern part of the exposure and was used as the quarry stone. When it is exposed to weathering it tends to break down into hand-sized chunks or lumps. The Helderberg Formation is the layered and very fossiliferous limestone north of the "lumpy" limestone. The Oriskany Formation includes the chert layers in the exposure north of the small shale pit about 200 feet north of the kiln. Each of these different rock types has its own particular set of fossils. The different fossil sets are one of the ways geologists identify the age of the rocks.

The Keyser limestone is more pure than the Helderberg limestone and was used a great deal by the local farmers as a source from which to make lime for fertilizer. Many abandoned kilns along the ridges of this county mark places where the farmers burned the Keyser limestone.

LOCALITY 52—SOMERSET COUNTY



LOCATION. In southern Somerset County, about ¾ mile west of Mt. Davis, the highest point in Pennsylvania, very fossiliferous limestone is mined and used as quarry rock. The best site for fossil collecting is at the Keystone Lime Co. Mine (indicated on the map by the crossed hammers). The mine is on the east side of the macadam road 1.8 miles west of the Mt. Davis State Forest Picnic Area. The outcrop is 1.3 miles north of Savage which is on the country road leading from Listonburg to Salisbury. Fossils are abundant in some layers of the limestone exposed on either side of the mine opening. *Do not enter the mine, this is private property.* The most accessible fossils are on the waste dump from the mine. The dump is located about 100 yards south of the mine on the west side of the road. Here the unusable shaly limestone has been discarded and weathering has broken the rock apart so that the fossils are easily collected.

FOSSILS. The limestone at the locality is full of fossils, mostly specimens of the Phylum Brachiopoda. A list of genera to be found is given below. Sketches of the fossils are shown in Plates 8 and 9. Some of the fossils, i.e., the Bryozoa and the Brachiopod genus *Orthotetes*, are very fragile and few complete specimens of these fossils are found. However, diligent search should provide good specimens of these plus the rare trilobite genus *Kaskia.*

BRACHIOPODS
- *Orthotetes*
- *Spirifer*
- *Diaphragmus*
- *Composita*

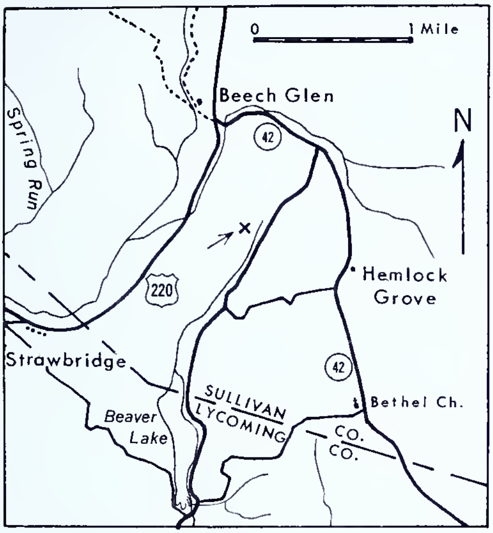
TRILOBITA
- *Kaskia*

BRYOZOA
- *Batostomella*
- *Fenestrellina*

GEOLOGY. The limestone at this locality is called the Greenbrier limestone. It was formed about 330 million years ago and is included in the Mississippian Period. The fossils and limestone are evidence of the presence of a marine sea in this part of Pennsylvania during the Mississippian Period.

Only the lower 10 feet of the limestone are used by the Keystone Lime Co. The seven feet of shaly limestone overlying the commercial bed contains too many impurities (mostly clay) to be used. This portion of the bed contains most of the fossils. When you make plans to visit this locality, include a trip to nearby Mt. Davis, the "top" of Pennsylvania.

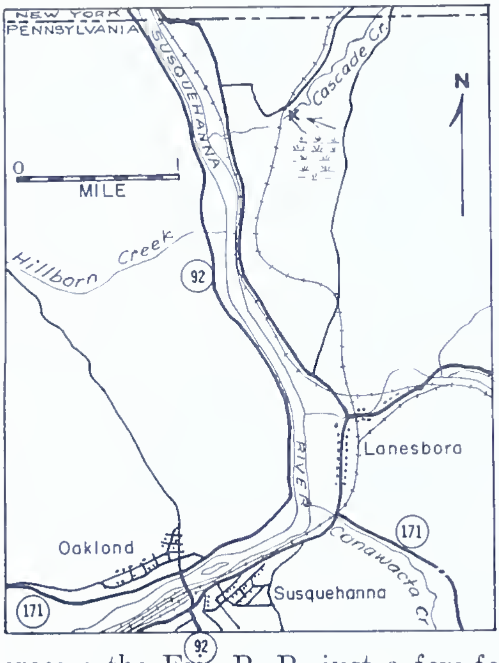
LOCALITY 53—SULLIVAN COUNTY



LOCATION. Sullivan County is underlain by non-marine rocks. Some parts of the county contain coal-bearing rocks and in those areas plant fossils may be found associated with the coal. The non-coal-bearing rocks of the county occasionally contain unusual fossils. A suggested locality where these unusual fossils may be collected is about one mile north of the Lycoming and Sullivan County boundary and 1.5 miles east of North Mountain Fire tower. The locality is 6 miles due south of Eagles Mere. The locality is reached by taking the paved road leading south toward Beaver Lake from its intersection with Pa. Route 42. This intersection is 0.7 mile east of the junction of U. S. Route 220 and Pa. Route 42. The locality is on the farm of a Mr. Meyers and *permission must be obtained before entering on this land.* The outcrop is about 600 feet due northwest of the next house and farm south from Mr. Meyers' property. The fossils are found in the rocks outcropping in the prominent middle bench on the hillside. Only a small portion of the rock in this middle bench contains fossils. The best fossils are collected where the bench follows the contour of the hill and the outcrop faces south toward the stand of trees. A few fossils have been found at other places along the middle bench but the best fossils are found in a space of only a few feet.

FOSSILS. Large fish scales are the only fossil to be found at this locality. The fish scales are white and stand out clearly against the dark-brown rock. Some of the scales are 1.5 to two inches in diameter. These scales are from a choanate fish. The genus is uncertain but it is possible that it could be *Rhizodus.* This fish was very large and may have been several yards in length.

GEOLOGY. The fish scales are found in the rocks of the Catskill Formation. They are nearly the last rocks to have been deposited during the Devonian Period. These rocks were deposited in streams that were building a large delta similar to the present delta of the Mississippi and the Nile Rivers. The constant erosion and deposition of the sands and muds in the delta destroyed most fossils but at this locality some scales were preserved. The same rocks also are of interest because they were prospected for uranium minerals. At several places along the middle bench a greenish mineral (Malachite) may be found encrusting some of the sandstone. This mineral shows slight radioactivity indicating the presence of unimportant traces of uranium.



LOCATION. Fossils may be found in the easternmost part of Susquehanna County in the area where the Susquehanna River re-enters Pennsylvania from New York State. The exposure is along Cascade Creek 0.5 mile west of the Susquehanna River and 0.6 mile south of the New York-Pennsylvania State line. The rock outcrop is reached by traveling north along the east bank of the river on the county road which intersects Pa. Route 171 at Lanesboro. A small dirt road leads east off the paved road 2.9 miles north of the Lanesboro road junction. The dirt road crosses the Erie R. R. just a few feet north of a high embankment over which the railroad crosses Cascade Creek. The rocks are exposed along the steep banks of the creek northeast of the road embankment. To approach the outcrop it is best to walk northeast along the upper part of the steep creek bank until a place may be found where it is safe to descend to the creek. Cascade Creek has cut a picturesque series of small falls near the railroad embankment and the creek banks are almost vertical and very high. Fossils are found in several thin layers interlayered with a great deal of non-fossiliferous rocks.

FOSSILS. Fossils are not abundant in these rocks and many of those that are present are represented by molds of the original shells. Some of the unweathered layers in the outcrop contain fossils with the original shell material. The most unusual features of the fossils at this locality is that plant fragments and fish scales are found with the brachiopods. The fossils listed below are illustrated in Plates 6 and 7.

BRACHIOPODS
- *Camerotoechia*
- *Cyrtospirifer*

CRICOCONARID
- *Tentaculites*

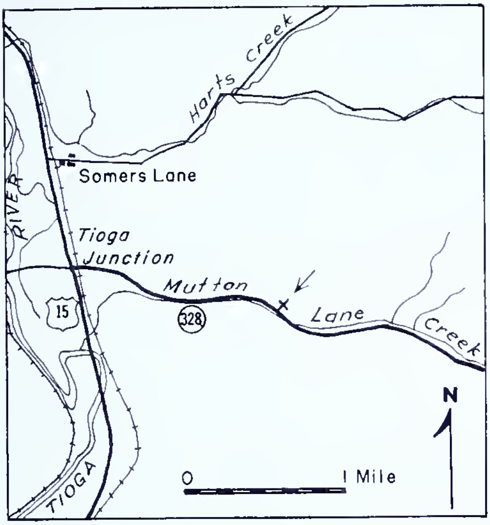
OSTEICHTHYES
- "Fish" scales

PLANTAE
- Plant fragments

CRINOID
- Columnals

GEOLOGY. The flat-lying rocks exposed in this picturesque setting belong to the West Falls Group. The rocks were deposited during the latter part of the Devonian Period about 360 million years ago. Most of the surface rocks in this eastern part of Pennsylvania contain no fossils. The few layers that do have fossils have unusual assemblages such as found here. The brachiopods and crinoids indicate that the water of the sea in which they lived was marine. The presence of the plant fragments and fish scales indicates that land must have been nearby.

LOCALITY 55—TIOGA COUNTY



LOCATION. Fossils may be found in many of the rock exposures along tributary streams to the Tioga River in the northern part of the county. One of these exposures is along the old road bed of the Erie R. R. on Mutton Lane Creek. The railroad no longer exists and the Commonwealth has used the road bed for its recent rebuilding of Pa. Route 328. The exposure is on the north side of the state highway across from a bridge 1.4 miles east of the junction of U. S. Route 15 and Pa. Route 238 in the village of Tioga Junction. The rock is exposed in a cut bank and in the bed of Mutton Creek south of the highway. Fossils may be found in many loose blocks and in some of the layers exposed in the road bank and stream bed. Another nearby locality worth visiting is 1.5 miles due west of the junction of U. S. Route 15 and Pa. Route 287 in the village of Tioga. This exposure is along the south side of the county road which follows the valley of Elkhorn Creek to Farmington Hill just west of the junction of the county road and Pa. Route 287.

FOSSILS. Pelecypods and brachiopods are relatively abundant at the Mutton Lane Creek locality. The exposure west of Tioga is interesting because it contains specimens of a "horn" coral. The fossils are illustrated in Plates 5, 6 and 7.

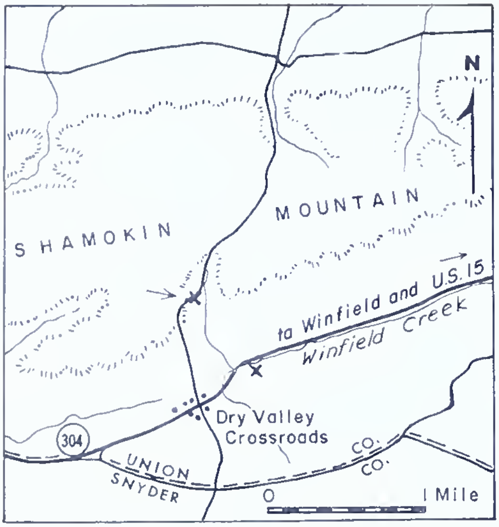
BRACHIOPODS
  Ambocoelia
  Atrypa
  Tylothyris
  Douvillina
  Whidbornella

PELECYPODS
  Edmondia
  Leptodesma
  Paleoneilo
  Sphenotus

CRINOID
  Columnals
BRYOZOA
  Batostomella
PLANTAE
  Plant fragments

GEOLOGY. The shales and sandstones exposed at these localities belong to the West Falls Group which was deposited late in the Devonian Period, about 355 million years ago. Unlike similar age rocks farther to the east in Susquehanna County, this exposure consists of shale and siltstone rather than sandstone. The number of fossil genera is also greater, indicating that the area was farther from the shore where more marine animals could live. The fauna is nearly restricted, however, to brachiopods and pelecypods, both of which are organisms adapted to living on muddy bottoms and in sediment-filled water. The occasional plant fragments pose a problem, however. If the shore was relatively distant these must have floated a long way before becoming trapped in the sediment.

LOCALITY 56—UNION COUNTY



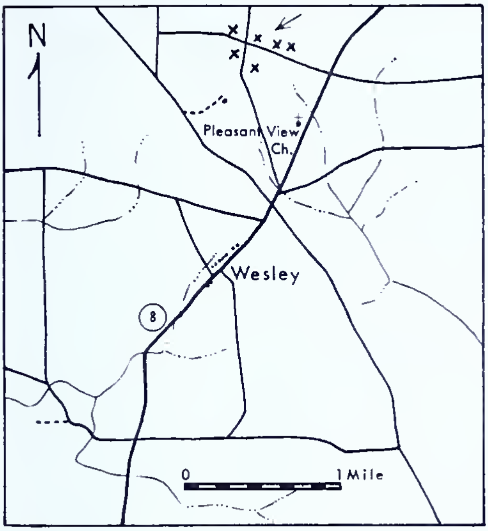
LOCATION. Two exposures, one on a dirt road and one in an abandoned farm quarry in southern Union County, are good localities where fossils may be collected. Both rock exposures are about three miles west of Winfield and the junction of Pa. Route 304 and U. S. Route 15. The first exposure is on the northwest side of a dirt road leading from Dry Valley crossroads across Shamokin Mountain. The outcrop is 0.8 mile north of Pa. Route 304. Several layers of sandstone and shale are exposed near where the road makes a bend. Fossils may be found in both the sandstone and shale layers. The second locality is 0.4 mile east of Dry Valley crossroads about 500 feet south of the highway. It is aproached by a farm road that follows the south side of Winfield Creek from the highway bridge over the creek. The exposure is in a quarry and is on private land. *Permission to collect from this quarry should be obtained from the owner.* Fossils may be found in many loose blocks on the quarry floor and in the exposed layers.

FOSSILS. Crinoid columnals, ostracodes, *"Paleophycus"* and trilobites may be collected at the first locality. *"Paleophycus"* is the result of an unknown organism which may have been a sea weed. All of the fossils are molds of the original shells. The trilobites and crinoid columnals are most frequent in the sandstones, the ostracodes are abundant in some shale layers. Bryozoa and corals are common in the limestones of the second locality. The fossils listed below are illustrated in Plates 3, 4 and 5.

- BRACHIOPODS
  - *Camerotoechia*
  - *Dalmanella*
- CORALS
  - *Cyathophyllum*
  - *Favosites*
- BRYOZOA
  - *Orthopora*
- PLANTAE
  - *"Paleophychus"*
- CRINOID
  - Columnals
- TRILOBITE
  - *Calymene*
- OSTRACOD
  - *Bonnemaia*
- CRICOCONARID
  - *Tentaculites*

GEOLOGY. The shales and sandstones exposed at the first locality belong to the upper part of the Rose Hill Formation which was deposited during the Silurian Period about 420 million years ago. The yellowish sandstones at the southern part of the exposure are called the Keefer Sandstone. The limestone exposed in the quarry is the Keyser Limestone; it was deposited near the end of the Silurian Period about 405 millions years ago. The reddish-brown sandstones of the Rose Hill Formation are called "iron sandstones" because they contain 15-20% iron.

LOCALITY 57—VENANGO COUNTY



LOCATION. Many coal strip mines in the southwestern part of Venango County expose fossiliferous limestones. The abandoned strip mines about 13 miles southwest of Franklin are suggested as sites for collecting. Several mines cover a large area about 1 mile north of the intersection of Pa. Route 8 and the "Georgetown Road" at the northeast end of Wesley. The "Georgetown Road" intersects Pa. Route 208 at Nectarine. The strip mines can be reached best by turning west onto the dirt road 0.9 miles north of the main road intersection at Wesley. The strip pits occur on both sides of the road and around its intersection with another dirt road 0.5 mile west of Pa. Route 8. The fossils are in the limestone which may be found exposed near the top of the high wall of the mines over the whole area. In many places when the pits are back-filled the limestone is easily reached.

FOSSILS. Fossils are not exceptionally abundant at this locality. Many of the fossils are imbedded in the limestone and are difficult to extract. There is, however, a large amount of limestone exposed in the area and fossils should be easily found. The fossils collected at this locality and listed below are illustrated in Plates 8 and 9.

Brachiopods
- *Marginifera*
- *Spirifer*
- *Phricidothyris*

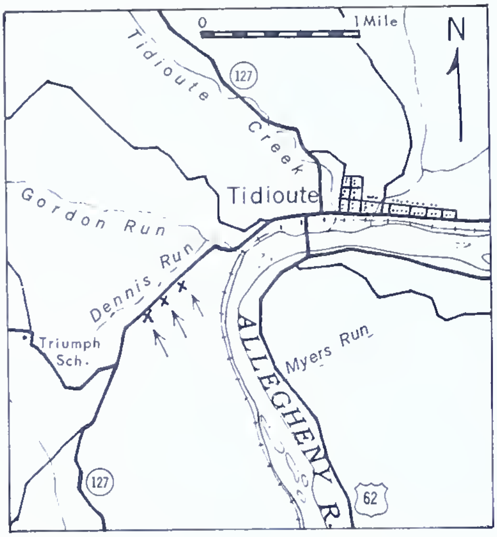
Crinoids
- Columnals

Echinoids
- Spines and plates

Coelenterate
- *Lophophyllidium*

GEOLOGY. The limestone exposed in the many strip mines of this area is the Vanport limestone. This limestone was deposited in a marine sea during the Pennsylvanian Period about 295 million years ago. The Vanport limestone is made up of shells of fossil animals and the mineral calcium carbonate. The limestone is very hard and difficult to break apart because the calcium carbonate cements the particles together. Many of the other Pennsylvanian Period limestones are easy to break apart because they contain a great deal of clay. The Vanport does not contain much clay and thus is a purer limestone. It was deposited during a time when the marine sea that covered this area was not receiving much sediment from streams that flowed into it. The calcium carbonate was derived from the many shell-forming animals that lived on the bottom of the sea. After these animals died the constant rolling about on the sea bottom caused by waves and currents broke the shells up into tiny fragments. These became cemented together and formed the limestone. Only a few shells were preserved completely.

LOCALITY 58—WARREN COUNTY



LOCATION. Warren County contains many rock layers that are filled with fossils. One of the best localities illustrating this occurs along the valley of the Allegheny River in the southern part of the county. The locality embraces a series of rock layers exposed on the south side of Pa. Route 127 where it climbs a steep hill and parallels a small stream called Dennis Run. The exposure is 1.1 miles west of the bridge which crosses the Allegheny River at Tidioute to U. S. Route 62. The fossiliferous layers are exposed at several levels as the road climbs the hill. Because the road is narrow and winding it is best to park vehicles at the top of the hill and walk back downhill a distance of about 500 feet to the fossiliferous layers. These layers, plus many fossiliferous blocks loose on the road bank, occur sporadically halfway to the base of the hill.

FOSSILS. The fossils encountered at this locality belong mainly to the Phylum Brachiopoda. Two genera of spiriferoid brachiopods, *Syringothyris* and *Cyrtospirifer* resemble each other but can be easily told apart because the first genus has a very high and triangular shaped pedicle valve while *Cyrtospirifer* does not. *Cyrtospirifer* also has radial lines over the whole shell while *Syringothyris* has them only on the sides and not along the medial part of the shell. The fossils found at this locality are all molds of the original shells. They are illustrated in Plates 6, 7 and 8.

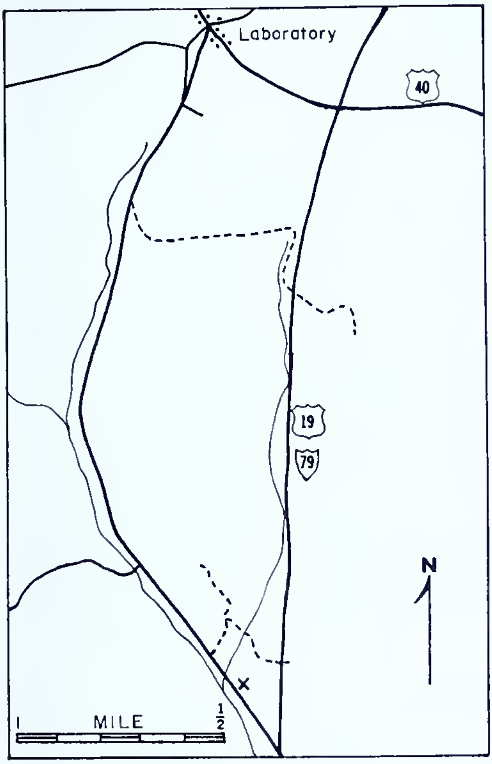
BRACHIOPODS
- *Buxtonia*
- *Camerotoechia*
- *Cyrtospirifer*
- *Dictyoclostus*
- *Lingula*
- *Paraphorhynchus*
- *Rhipidomella*
- *Syringothyris*

GASTROPOD
- *Euomphalus*

CRINOID
- Columnals

PELECYPODA
- *Aviculopecten*
- *Paleoneilo*

GEOLOGY. The rocks exposed along the road paralleling Dennis Run belong to the Corry Formation and the Oswayo Formation. The Corry is at the top of the hill; the Oswayo extends from there downward to the bottom of the hill. These rocks were deposited during the latter part of the Devonian Period and early part of the Mississippian Period. These fossiliferous rocks which are sandstones, interlayered with shaly rocks, probably were formed as part of offshore bars and beaches in an ancient marine sea. The brachiopods and pelecypods were about the only animals able to live in this type of environment; thus we find mainly their fossils.

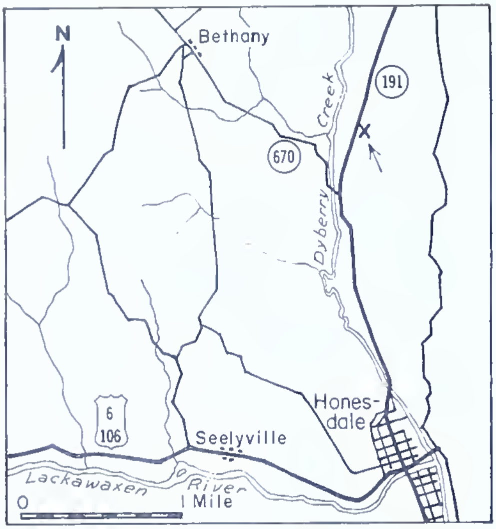


LOCATION. A small abandoned quarry on the east side of a county road (old U. S. Route 19) 1.7 miles south of the intersection of U. S. Routes 40 and 19 in Washington County is a site where some rare fossils may be found. The exposure is 0.2 mile north of the present southern end of Federal Highway 79. Consult the map for more detailed directions. Because the quarry is now part of a pasture and is accessible only by crossing over a fence, it is necessary to secure permission from the owner before entering.

FOSSILS. Three types of fossils that may be found at this site are illustrated in Plate 10. Because the fossils are quite small, a magnifying lens of about 10 power is a necessary tool for collecting at this locality. The fossils to be found are: 1. worn shells—small coiled shells, much like a snail, which housed a worm called *Spirorbis* (class Polychaeta); 2. ostracodes—small pea-shaped shells that contained tiny crustaceans. They belong to the genus *Cytherella.* Although having little resemblance to crabs and lobsters, also crustaceans, the ostracods are their relative. This relation is proved by the fact that living ostracods bear several sets of jointed legs similar to the legs of crabs and lobsters; 3. fish teeth—the single teeth and bony plate fragments found here belong to the genus *Paleoniscus* (class Osteichthyes); the two-pronged teeth are from sharks (class Chondrichthyes) possibly the genus *Diplodus.*

GEOLOGY. The rock in which the fossils are found is called the Upper Washington limestone. It is part of the Washington Formation, a series of flat-lying, upper Paleozoic Era (Permian Period) sandstones, shales, and limestones that underlie most of the region. In the quarry the ostracods are common in the limestone and shaly interlayers; the fish teeth and worm shells are found in the shaly interlayers. The best place to look for fish teeth is on some of the large blocks on the quarry floor and at the top of the uppermost limestone layer in the quarry wall. The fossils found in the limestones and shales of the Washington Formation, plus the plant fragments and coal found in overlying and underlying rocks, indicate that these rocks were formed in fresh-water lakes, swamps, and streams.

LOCALITY 60—WAYNE COUNTY

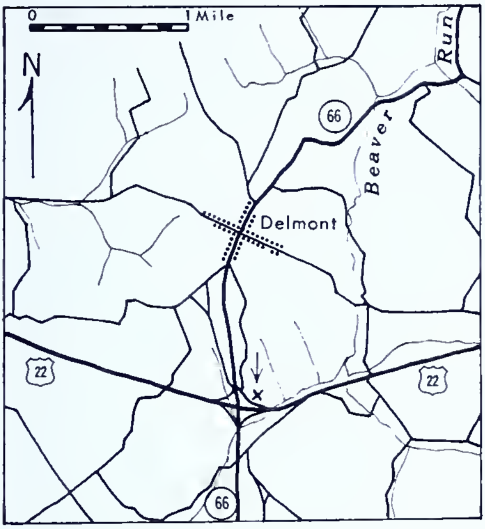


LOCATION. The rocks underlying Wayne County are almost totally unfossiliferous. Thus localities where fossils may be collected are very rare. One such locality exists north of Honesdale. This may be visited to obtain plant fossils which are older than most plant fossils commonly found in other areas of Pennsylvania. The outcrop to visit is along the new portion of Pa. Route 191 which was constructed to bypass the newly built Jadwin Dam Reservoir 2.5 miles north of Honesdale. The exposure is on the east side of the highway, 0.4 mile north of the intersection of Pa. Routes 670 and 191 at the Wayne County fairgrounds. The new outcrop exposes many layers of brown and reddish sandstone with some shale. The fossils are found in scattered blocks along the base of the slope and at several levels on the hillside.

FOSSILS. The only fossils to be found at this locality are specimens of trunks and roots of trees and plants. Most of these are recognized by the carbonized woody material associated with the rocks. Some of the carbonized pieces are large enough to be called coal. They differ from real coal, however, in that the material is made from a single plant while coal is the result of accumulation of a great deal of plant material. No genera have been recognized from the fossils collected here because the fossils are too fragmental. Diligent searching may reveal large enough specimens to be identified.

GEOLOGY. The flat lying layers of rock at this locality belong to the Catskill Formation. These rocks were deposited almost at the end of the Devonian Period about 350 million years ago. All of these rocks were deposited in a huge delta similar to the modern Mississippi or Nile deltas. The rocks were deposited by the many delta distributary streams that constantly changed their course, eroding new channels and depositing their heavy load of sand and mud. The types of plants and trees that were to become so abundant during the Mississippian and Pennsylvanian Periods started to grow in swamps along the delta streams. Some of the plants were swept into the stream channels and buried with the sand and mud. Perhaps this occurred during a spring flood when a great deal of sediment was being transported and the trees were uprooted and carried in the fast currents. The fast deposition prevented their decay and the weight of further sediment on them caused them to turn to "coal."

LOCALITY 61—WESTMORELAND COUNTY



LOCATION. Westmoreland County, like most of the western counties in Pennsylvania, is underlain by nonmarine rocks formed when the great coal swamps occupied this area. During this period of geological history, limestones were deposited in marine seas which occasionally covered all of western Pennsylvania. The locality recommended for Westmoreland County is an exposure of one of these limestones. The outcrop is about 7.5 miles north of Greensburg at the junction of U. S. Route 22 and Pa. Route 66. The exposure is on the northeast side of the cloverleaf exchange 1 mile south of New Salem. To get to the exposure follow U. S. Route 22 west. Turn right (north) at the east end of the cloverleaf as if to drive north to Pa. Route 66. The limestone is exposed about midway between the U. S. and State highways in the bank northeast of the road. Vehicles can park without much difficulty on the road shoulder. Beware of vehicles turning off U. S. Route 22 for Pa. Route 66.

FOSSILS. As with many of the thin marine limestones of western Pennsylvania, crinoid fragments and small brachiopods are the most common fossil. Many very excellent specimens of *Chonetes* and *Cruithyris* may be collected here. These fossils are illustrated in Plates 8 and 9.

BRACHIOPODS
- *Chonetes*
- *Crurithyris*
- *Derbya*
- *Rhipidomella*

CORAL
- *Lophophyllidium*

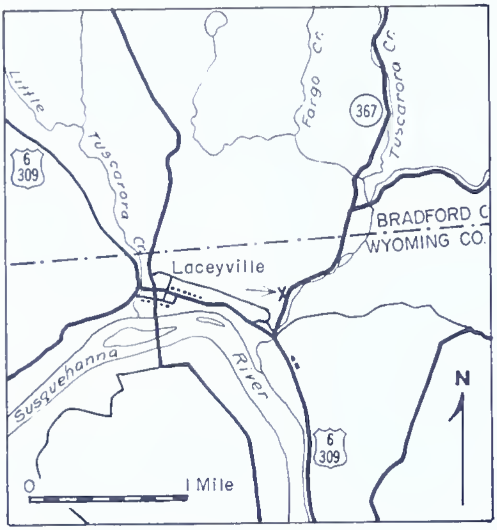
PELECYPOD
- *Cypricardina*

GASTROPOD
- *Ianthinopsis*

CRINOID
- Columnals

GEOLOGY. The limestone exposed at the cloverleaf locality is called the Ames limestone. It was deposited during the Pennsylvanian Period about 290 million years ago. The Allegheny, Beaver and Cambria County localities all are exposures of the Ames limestone. Each is somewhat different from each other in the type of rock and fossils exposed. The rock exposed at the Westmoreland County locality is most nearly like the rock exposed at the Allegheny County locality, but the fossils are a bit different. Fewer genera of fossils occur in the Ames at this locality than at the Allegheny County exposure. The Allegheny County locality may represent part of the sea bottom farther to sea where currents were less swift and the water clearer and a more varied group of animals could live. The areas closer to shore, as may have been the case in the Cambria and Westmoreland County localities, would be subject to swifter currents and muddier waters where fewer types of animals could live.

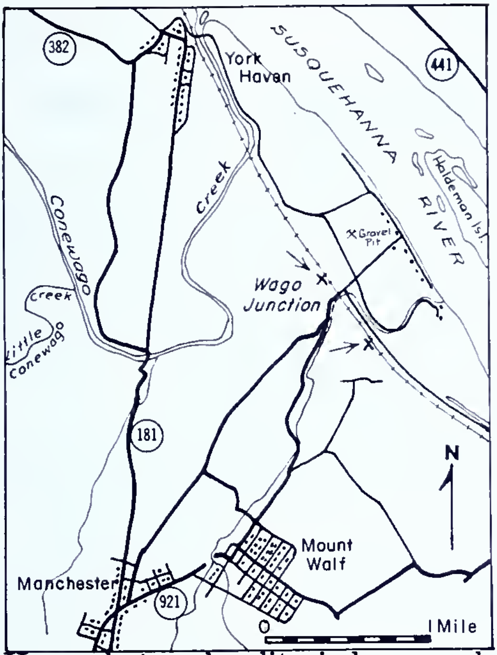
LOCALITY 62—WYOMING COUNTY



LOCATION. Near the northwestern-most corner of Wyoming County the Susquehanna River and its tributaries have eroded deeply into the non-marine and coal-bearing rocks that underlie most of the country. In this area some of the sediments deposited in the late Devonian Period marine sea have been exposed by this erosion. The fossiliferous exposures selected for Wyoming County is in these rocks and is about 16 miles northwest of Tunkhannock. It is just north of U. S. Routes 6 and 309 on the north side of the Susquehanna River. The exposure is along the north side of Pa. Route 367, 0.35 mile north of its junction with the U. S. highway east of Laceyville. At the collecting locality the state highway is compressed between the rock exposure and the bank of Tuscarora Creek. Thus, it is necessary to park vehicles some distance north or south of the exposure. Collectors should exercise extreme caution at this locality because of the closeness of the exposure to the pavement. Fossils may be collected from the ledges next to the highway and from some loose blocks nearby.

FOSSILS. The rocks exposed at this locality are full of large specimens of *Cyrtospirifer* almost to the exclusion of other fossils. Specimen of the small brachiopod *Camerotoechia* are present but rare. Occasionally fragments of some plant fossils are found also. These fossils are illustrated in Plate 7.

GEOLOGY. The fossiliferous rock exposed near Laceyville is most unusual in that it contains many thousands of specimens of the large brachiopod genus *Cyrtospirifer.* It is uncertain why one rock layer, so completely filled with fossils, should be interlayered with other rocks which contain no fossils. One explanation might be that this brachiopod, because of its size, was adapted to live in the particular environment of swift currents which deposited these sandstones. The large size would have made the animal heavy and thus it would not easily roll around or if it did roll with the currents the strong shell would protect it. During the time that this animal lived on the sea bottom, the amount of mud and sand that was being brought to the sea must have decreased somewhat or the animals would have been smothered by the sediment. The closest type of existing environment similar to the one represented by these very fossiliferous layers may be the coastal oyster beds where thousands of oysters live close together.



LOCATION. York County is underlain by a remarkable diversity of sedimentary and metamorphic rocks. Unfortunately, few of these rocks are fossiliferous and even those few contain but a small amount of poorly preserved fossils. In the vicinity of York Haven a few rock layers associated with the red shales and sandstones that predominate in this area contain plant fossils. Excellently preserved ferns and leaves were found many years ago south of York Haven but the locality has not been rediscovered. Petrified wood has been collected from some of the fields near York Haven but no locality is known where they can be collected now. In the rocks exposed along the Pennsylvania Railroad near Wago Junction, however, some of the brownish and yellowish sandstone and shale layers contain fragments of plant fossils. Wago Junction is two miles south of York Haven and 2.4 miles northeast of Pa. Routes 151 and 921 in Manchester. Two exposures, one north and one south of the road from Manchester, contain plant fossils. The northern exposure is about 175 feet north of the power transformer between the main railroad and the spur track to Manchester. The rocks are exposed behind a dense curtain of small trees and brush. The southern exposure is about 1000 feet south of the road. The fossiliferous rocks are about 200 feet north of a cement culvert carrying a stream under the railroad. Fossil plants may be collected here in loose blocks along the track and in the outcrop. The more shaly layers contain the best-preserved fossils.

FOSSILS. Only carbonized remains of trunks, limbs and roots are common at these exposures. A few shaly layers have poorly preserved leaf and fern impressions. The genus *Cheirolepis* has been tentatively identified from these rocks. It is possible that some of the larger trunk specimens are from the genus *Calamites.* Illustrations of these fossils are found in Plate 10.

GEOLOGY. The rock exposed along the railroad south of York Haven belong to the New Oxford Formation. These rocks were deposited in rivers, lakes and streams during the Triassic Period over 200 million years ago. They are nearly the youngest rocks to exist in Pennsylvania. The plants are the youngest plant fossils to be found in the state. They were preserved where streams deposited sand and mud rapidly and covered the trees and plants that fell into the water.

DISPLAYS OF FOSSILS IN PENNSYLVANIA COLLEGES AND MUSEUMS

Many Pennsylvania colleges and museums maintain collections of fossils for public use as well as for study by students and professional paleontologists. To help familiarize yourself with fossils you should visit these exhibits. They will help you learn about the many kinds of fossils that exist as well as help you identify the fossils you may collect. The curators who take care of the collection will, in most cases, be able to help you with your problems of identification.

Some of the colleges and smaller museums do not have their exhibits open to the public. To examine these collections, which are generally small collections used in teaching, it is necessary to make an appointment with those in charge.

For help on fossil identification you may wish to contact the Science Departments of the many Pennsylvania colleges, even if they do not have any displays or collections. Many of the Science Departments of these colleges include geologists on their staff who will often be able to help you identify fossils.

ALLEGHENY COUNTY

Carnegie Institute, 4400 Forbes Avenue, Pittsburgh

This excellent museum should be visited by all fossil collectors to see the reconstructions of fossils as they once lived as well as typical kinds of fossils. Specific halls to visit are:

1. Insect and Invertebrate Hall—lives and habits of living invertebrates
2. Fossil Hall—reconstructions of late Paleozoic fossils emphasizing plants, reptiles and invertebrates
3. Paleozoic Hall—nine dioramas illustrating various parts of the Paleozoic Era, typical fossils of each depicted time are in front of the cases
4. Dinosaur Hall—large reptiles and fish emphasizing the dinosaurs
5. Fossils Mammal Hall—the development of mammals in North America
6. Mammal Hall—the extinct mastodon, mammoth, bison and others; invertebrate fossils are also displayed in cases in this room.

Several Natural History clubs are directed by the Institute. For information about them contact the museum personnel.

The Institute is open week days 10:00 A. M. to 5:00 P. M., Tuesdays 10:00 A. M. to 9:00 P. M. during mid-October to March, Sundays 2:00 to 5:00 P. M.

BERKS COUNTY

Reading Public Museum and Art Gallery, 500 Museum Road, Reading

On display are exhibits of birds, mammals, reptiles, fish and insects. Fossil displays include local fossils illustrating most of the Paleozoic and Cenozoic Eras.

Collections include the Unger Collection of plant fossils from the Pennsylvanian Period as well as a general collection of fossils. To see the collections it is necessary to make appointments.

The museum is open weekdays 9:00 A. M.-5:00 P. M., Saturdays 9:00 A. M.-12:00 Noon, Sundays 2:00 to 5:00 P. M.

BRADFORD COUNTY

Bradford County Historical Society, Court Street, Towanda

Together with a large amount of local Indian relic material The Bradford County Historical Society has two cases partially devoted to fossils which were collected from the local area.

The museum is open Wednesday and Thursday from 2:00 to 4:30 P. M. and Friday from 7:00 to 9:00 P. M.

Tioga Point Museum, 724 S. Main Street, Athens

In addition to fine paleontologic material from outside Pennsylvania this museum has fossils from the local area. Most of the major groups of fossils are included in the collection which is housed in open display cases.

The museum is open Mondays 7:00 to 9:00 P. M., Wednesday and Saturday 2:00 to 5:00 P. M., other times by appointment.

CENTRE COUNTY

Pennsylvania State University, State College

In the halls of the southwest wing of the Mineral Industries Building are illuminated cases of reconstructed fossils as follows:

1. Cenozoic Age of Mammals
2. Mesozoic Age of Reptiles and Ammonites
3. Carboniferous Age of scale trees and stegocephations
4. Devonian Age of primitive fishes and Golden Age of brachiopods
5. Early Paleozoic Age of Invertebrates

Those cases include reconstructed models of invertebrate, vertebrate and plant fossils.

Special teaching collections for college courses in paleontology and scientific collections of the teaching staff are also present. Contact the Department of Geology for visiting hours and for help in identifying fossils.

CRAWFORD COUNTY

Allegheny College, Meadville

The Department of Geology has many displays of fossils. In the halls of Alden Hall are cases displaying typical fossils from the Meadville area (plants and invertebrates), mastodon bones and teeth, and representative specimens of most phyla. Those are open daily during college sessions.

The basement of Alden Hall houses an extensive geological museum including plant fossils, rare echinoderms, plaster reproductions of vertebrate tracks and bones. The museum is open week days 2:00 to 5:00 P. M. and Saturdays 10:00 to 12:00 A. M. during college sessions. Contact the Geology Department for guides to the museum.

CUMBERLAND COUNTY

Dickinson College, Carlisle

On display in Althouse Science Building is the "George S. Rennie III Collection of Vertebrate Fossils" which includes original and reproduced specimens of many vertebrate fossils. Also on display is a collection showing the evaluation of plants from the Cambrian to the present. In addition there is a research collection of invertebrate and vertebrate fossils. The collections are open to the public during school hours and evenings by appointment.

DAUPHIN COUNTY

Pennsylvania Geological Survey, Department of Internal Affairs, Harrisburg

The Geological Survey has a small general collection illustrating the invertebrate and plant phyla. A few of the better specimens are displayed in hall cases. Larger collections are maintained for scientific study and are available to the public. Appointments must be made to examine the collections.

Pennsylvania State Museum, Harrisburg

The State Museum, currently expanding and moving to a new building will have areas devoted to natural science with exhibits of fossils from Pennsylvania and elsewhere. The museum will also house the extensive fossil collections of the Geologic Surveys of the 1800's and the James collection of plant fossils.

Hours for visiting are Monday through Saturday 8:30 A. M. to 5:00 P. M. and Sundays 1:00 to 5:30 P. M.

DELAWARE COUNTY

Delaware County Institute of Science, 11 South Avenue, Media

The institute has a general collection of fossils from Pennsylvania and elsewhere. About 125 specimens are in the display. Contact the Institute for the hours they are open.

ERIE COUNTY

ERIE PUBLIC MUSEUM, 356 W. 6th Street, Erie

The Erie Museum has one case devoted to fossils from the Devonian and younger geologic periods. The museum is open every day except Monday from 10:00 A. M. until 5:00 P. M.

GREENE COUNTY

WAYNESBURG COLLEGE, Waynesburg

The college museum has on display and in study collections a large number of specimens of representative fossils from the southwestern counties of Pennsylvania. The museum also has extensive material from the famous insect and plant locality of Florrisant, Colorado.

Contact the administrative office for information on visiting their collections.

LACKAWANNA COUNTY

EVERHART MUSEUM OF NATURAL HISTORY, Science and Art, Scranton

The Everhart Museum has a large collection of plant fossils of which about 24 are displayed in one case.

Contact the museum for their hours of visiting.

LACKAWANNA HISTORICAL SOCIETY, 232 Monroe Avenue, Scranton

The Edward S. Jones collection of fossil ferns and trees is housed at the Society with 37 specimens exhibited in cases. The society is open to the public Tuesday to Friday; 10:00 A. M. to 5:00 P. M. and Saturday 10:00 to 12:00 A. M.

LANCASTER COUNTY

NORTH MUSEUM, Franklin and Marshall College, College Avenue, Lancaster

In addition to small dioramas depicting "Life Through the Ages" the museum has displays of fossils emphasizing one or more phyla. The museum collections include a great deal of local fossils from the lower Cambrian, Ordovician and Silurian and Devonian.

The Museum sponsors a Junior Earth Science Club for young people interested in collecting fossils, rocks and minerals.

Contact the museum for their visiting hours.

LUZERNE COUNTY

WYOMING HISTORICAL AND GEOLOGICAL SOCIETY, 69 S. Franklin Street, Wilkes-Barre

The Society has on display plant fossils derived from the Anthracite coal fields. The Society possesses the LaCoe Collection of Paleozoic Fossils which is stored at Wilkes College.

To examine those fossils contact the Society.

MONTGOMERY COUNTY

BRYN MAWR COLLEGE, Department of Geology, Bryn Mawr

The paleontology museum of the Bryn Mawr Geology Department has 14 small display units. These displays include typical fossils from the various eras, models of dinosaurs and ancient man, and displays on several of the major fossil groups.

The study and research collections total 25,500 specimens, with emphasis on modern mollusks, Cenozoic fossils from Maryland, and an extensive set of fossils arranged by phyla.

The display material is open to the public during regular college hours. The research material is available by pre-arrangement with the curators of the museum.

NORTHAMPTON COUNTY

LAFAYETTE COLLEGE, Dept. of Geology, Easton, Penna.

The public displays at Lafayette College include cases illustrating "The Nature and Significance of Fossils", "Succession of Organisms in Time", and newly acquired fossils. Study collections are available to students.

Marble Hall, where the displays are kept, is open 8:00 A. M. to 4:00 P. M. Monday to Friday, and 8:00 to 12:00 A. M. Saturday. Examination of the study collections is by appointment.

LEHIGH UNIVERSITY, Department of Geology, Bethlehem

The fossil collections at Lehigh are primarily for teaching. A few hall cases contain fossil displays that change from time to time. To examine the displays and study collections contact the Geology Department.

PHILADELPHIA COUNTY

THE ACADEMY OF NATURAL SCIENCES, 19th & The Parkway, Philadelphia 3

In the Hall of Earth History are many exhibits of fossils covering the major geologic periods. In addition, a large dinosaur is shown with a mural reconstruction.

Study collections specialize in Mesozoic and Cenezoic fossils, but Paleozoic fossils from Pennsylvania are included. Arrangements can be made with the museum to examine the study collection.

The educational department of the museum offers two one-hour-long lessons to class-size groups. These are given by pre-arrangement with the museum staff. One lesson (at the 4th to 5th grade level) is an Introduction to Dinosaurs, the other lesson (5th to 9th grade level) is on Prehistoric Life. Adult programs on earth history and paleontology are offered every few years to interested people.

The displays are open 10:00 A. M. to 5:00 P. M. Monday to Saturday and 1:00 to 5:00 P. M. Sunday.

THE PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE, 43rd, Kingsessing and Woodland Aves.

The College Museum maintains a small museum in which they display many fossil specimens, emphasizing plants and the invertebrate phyla.

The displays are available to the public. Entrance to the museum must be secured by visiting the office in the main college building.

WAGNER FREE INSTITUTE OF SCIENCE, Montgomery Ave. and 17th St., Philadelphia 31

On display at the Institute are 16 large cases exhibiting vertebrate and invertebrate fossils. The cases are organized by geologic periods. Two other cases emphasize plant and invertebrate fossils from Pennsylvania.

The collections are open to the public 10:00 A. M.-5:00 P. M. Monday to Friday. The Institute also sponsors a free lecture series on Geology, including paleontology.

UNION COUNTY

BUCKNELL UNIVERSITY, Department of Geology, Lewisburg

The Department of Geology has an extensive study collection of invertebrate fossils. These are available for examination on prior request to the Department.

YORK COUNTY

THE HISTORICAL SOCIETY OF YORK COUNTY, 250 E. Market St., York

The Historical Society has a small collection of invertebrate, vertebrates and plants. They are available upon request when the Society is open—9:00 A. M. to 5:00 P. M. Tuesday through Saturday.

WESTMORELAND COUNTY

ST. VINCENT ARCHABBY, Latrobe

The museum at St. Vincent contains a small collection, mostly plant fossils from the local area. The museum is open 1:00 to 4:00 P. M. Sundays. Other times by appointment.

ADDITIONAL READING

BOOKS ON PALEONTOLOGY

BOOKS GENERALLY SUITABLE FOR AMATEURS. ARRANGED IN GENERAL ORDER OF INCREASING COMPLEXITY.

Geology Merit Badge, Boy Scouts of America, (1953). Contains one short chapter outlining fossils.

First Book of Prehistoric Animals, by Alice Dickinson. Franklin Watts, Inc. New York, N. Y., (1954). For grade schools.

Animals of Yesterday, by B. M. Parker. Basic Science Education Series, Row, Peterson and Co., Evanston, Ill. (1948). Well illustrated for grades and junior high.

The Dinosaur Book, by E. H. Colbert. McGraw-Hill, New York, N. Y. (1951). An extensive discussion of fossils, their history and variety, emphasizing fossil reptiles. For all ages.

The Fossil Book, by C. L. Fenton & M. A. Fenton. Doubleday, Garden City, New York (1958). An excellent, easily read reference book for the interested amateur of high school to adult age.

Fossils in America, by Jay Ellis Ransom. Harper and Row, New York, Evanston, and London. (1964). A popular-level book listing fossil localities throughout the United States. Contains an easily read discussion of the nature, origin, identification, and classification of fossils.

Fossils, An Introduction to Prehistoric Life, by William H. Matthews, III. Barnes and Noble, New York. (1962). A paper-back book which quite thoroughly covers all of the information needed by the fossil hunter. The book is well illustrated and contains numerous references for additional reading and sources of information.

Search For the Past, An Introduction to Paleontology, by James Beerbower. Prentice-Hall, New York, N. Y. (1960). An excellent, up-to-date, college level text that may be of interest to the adult amateur.

Index Fossils of North America, by H. W. Shimer and R. R. Shrock, John Wiley & Sons, New York, N. Y. (1944). A detailed survey of fossils devoted mainly to illustrations of North American Fossils.

GENERAL BOOKS ON HISTORICAL GEOLOGY

Man, Time and Fossils, by Ruth Moore, Alfred Knopf, New York, N .Y. (1953). The development of fossils through geologic time.

Time, Life and Man, by R. A. Stirton, John Wiley & Sons, New York, N. Y. (1959). A high school and college level introductory text on the earth's history emphasizing paleontology, especially vertebrate fossils.

Record of the Rocks, by H. G. Richards, Ronald Press, New York (1953). An introductory high school and college text of earth history with many notations on the rocks of Pennsylvania and other eastern states.

FOSSIL COLLECTING IN NEARBY STATES

An Illustrated Guide to Fossil Collecting, by Richard Casanova. Naturegraph Co., San Martin, Calif., (1957). A short, non-technical booklet, with a list of collecting localities for most states.

Ohio Fossils, by A. LaRocque & M. Marple. Ohio, Division of Geological Survey, Bulletin 54, Columbus 10, Ohio (1955). An introduction to the paleontology of Ohio. Identification keys and collecting localities are given.

Guide for Beginning Fossil Hunters, by Charles Collinson. Illinois Geological Survey, Educational Series 4, Urbana, Illinois (1959). A well-written, simple booklet on finding and collecting fossils. Illinois localities are given.

Field Book—Pennsylvanian Plant Fossils of Illinois, by Charles Collinson and Romayne Skartvedt. Illinois Geological Survey, Educational Series 6, Urbana, Illinois (1960). Similar to the above booklet in treatment except that it concerns only plant fossils. Very well illustrated with numerous localities cited.

Adventures with fossils, by Robert Shaver. Geological Survey, Indiana Department of Conservation, Circular 6, Bloomington, Indiana (1959). A popular account of fossils with several Indiana localities cited.

Many other states have published booklets on fossils with information on collecting localities. To obtain these, should you wish to visit a particular state, write to the Geological Survey of that state and request their help.

OTHER POPULAR PUBLICATIONS OF THE PENNSYLVANIA GEOLOGICAL SURVEY

Bulletin ES 1. Common Rocks and Minerals of Pennsylvania*
Bulletin ES 2. Common Fossils of Pennsylvania*
Bulletin ES 3. Ground Water*
Bulletin ES 4. Pennsylvania Geology Summarized*
Bulletin ES 5. Geology and the Gettysburg Campaign*
Bulletin ES 6. Pennsylvania and the Ice Age*
Bulletin G-33. Mineral Collecting in Pennsylvania**
Map 1. Geologic map of Pennsylvania (1960). Scale: 1:250,000 (1″ = 4 miles)***

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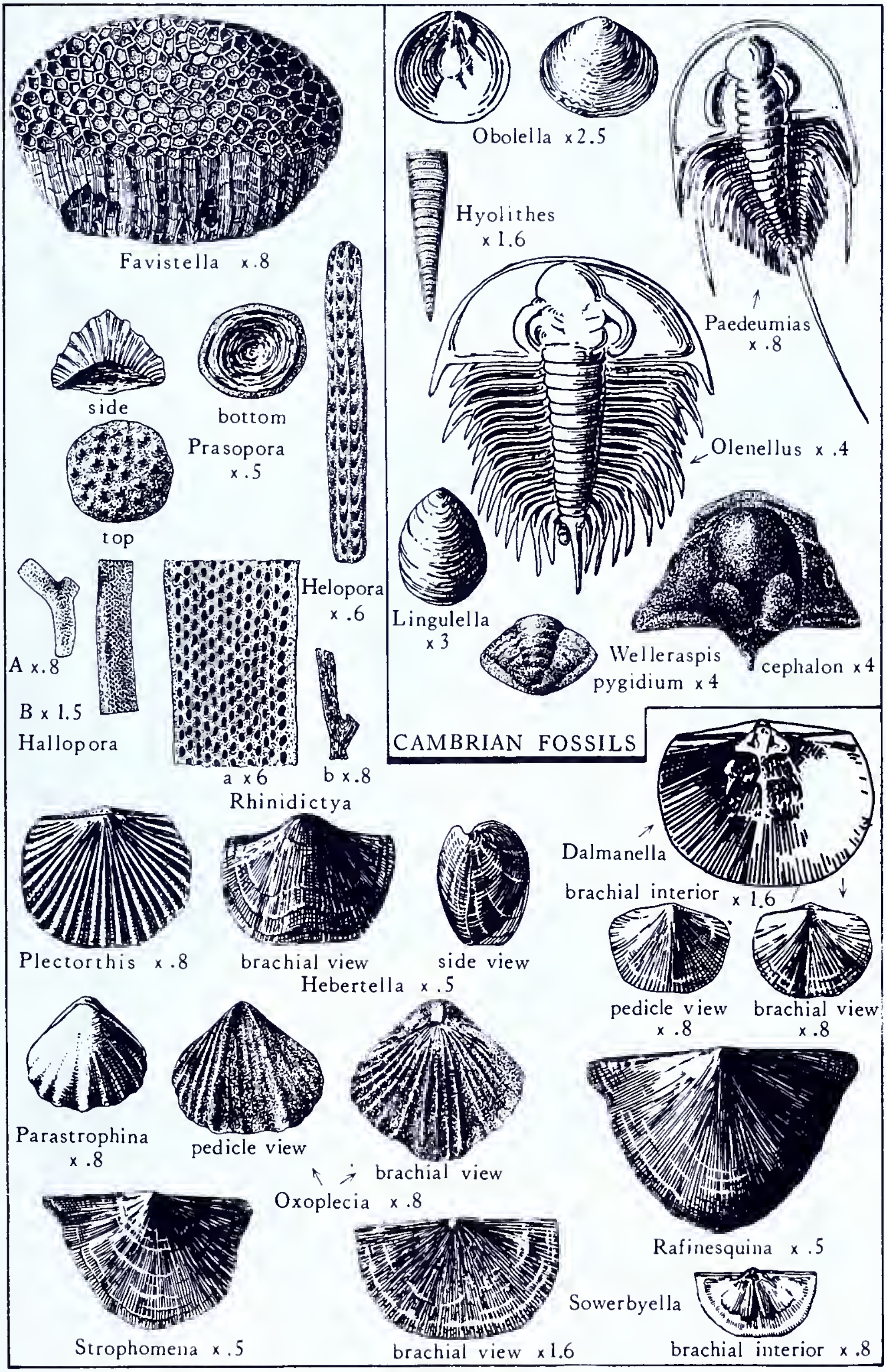
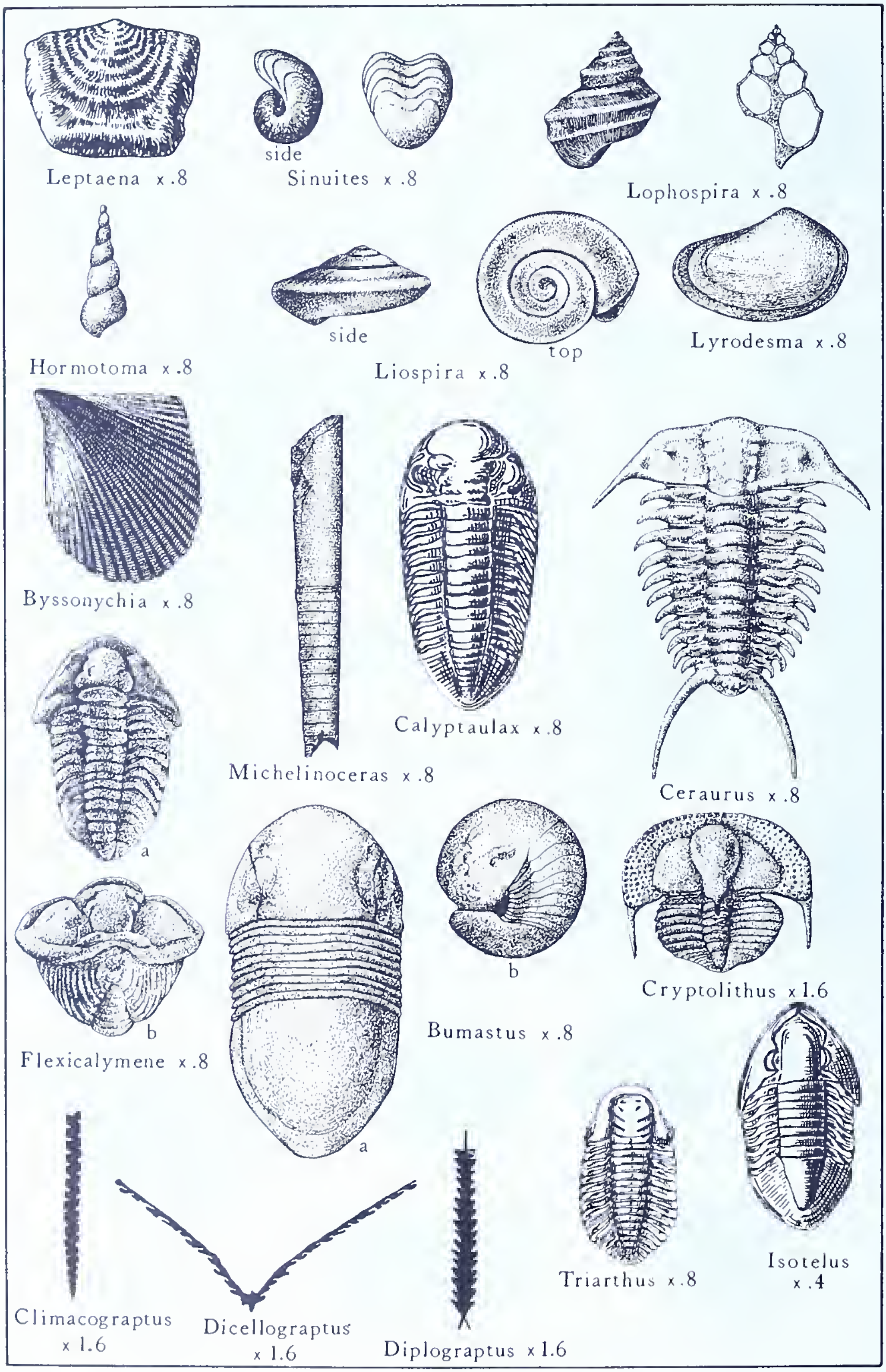
* Free. Order from Pennsylvania Geological Survey, Department of Internal Affairs, Harrisburg, 17120.

** $.50, *** $3.75 (Both plus 5% State sales tax for Pennsylvania residents). Order from Division of Documents, 10th and Market Streets, Harrisburg, 17125.

CAMBRIAN & ORDOVICIAN FOSSILS Plate 1

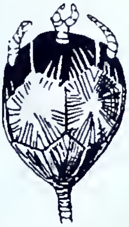


ORDOVICIAN FOSSILS Plate 2

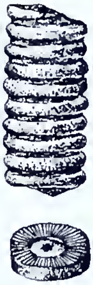


ORDOVICIAN, SILURIAN FOSSILS

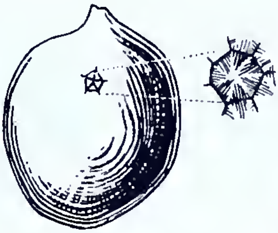
Plate 3



Carabocrinus
x.8

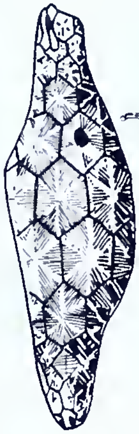


crinoid stem
x 4

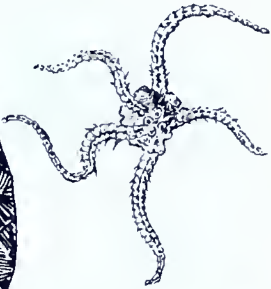


Echinosphaerites
x.8

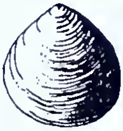
ORDOVICIAN FOSSILS



Caryocystites x.8

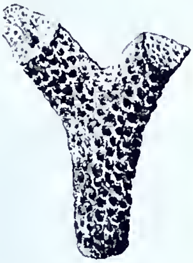


Hallaster x3

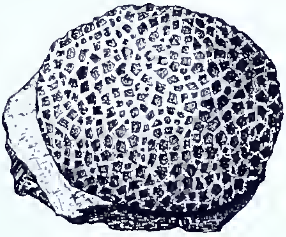


Leptobolus x1.6

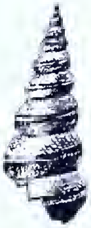
SILURIAN & DEVONIAN FOSSILS



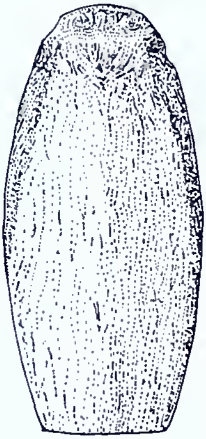
Coenites x.8



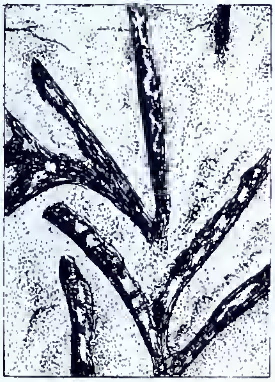
Favosites x.8



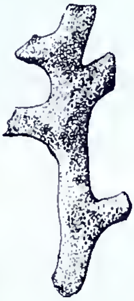
Hormotoma x1.6



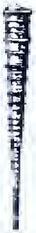
Americaspis x.4



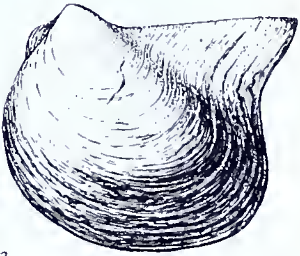
"Paleophycus"



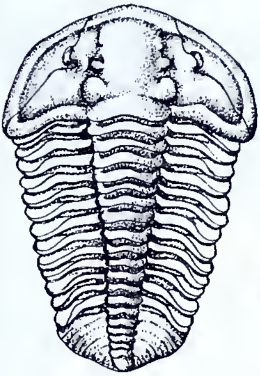
Rhombotrypa
x2.5



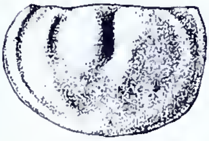
Tentaculites
x1.6



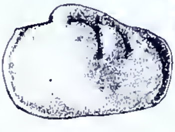
Liopteria x.8



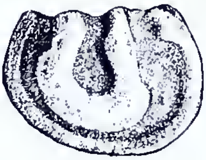
Calymene x1



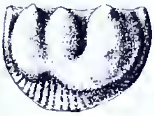
Kloedenia x8



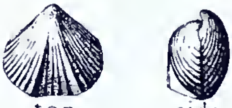
Kloedenella x13



Bonnemaia x6

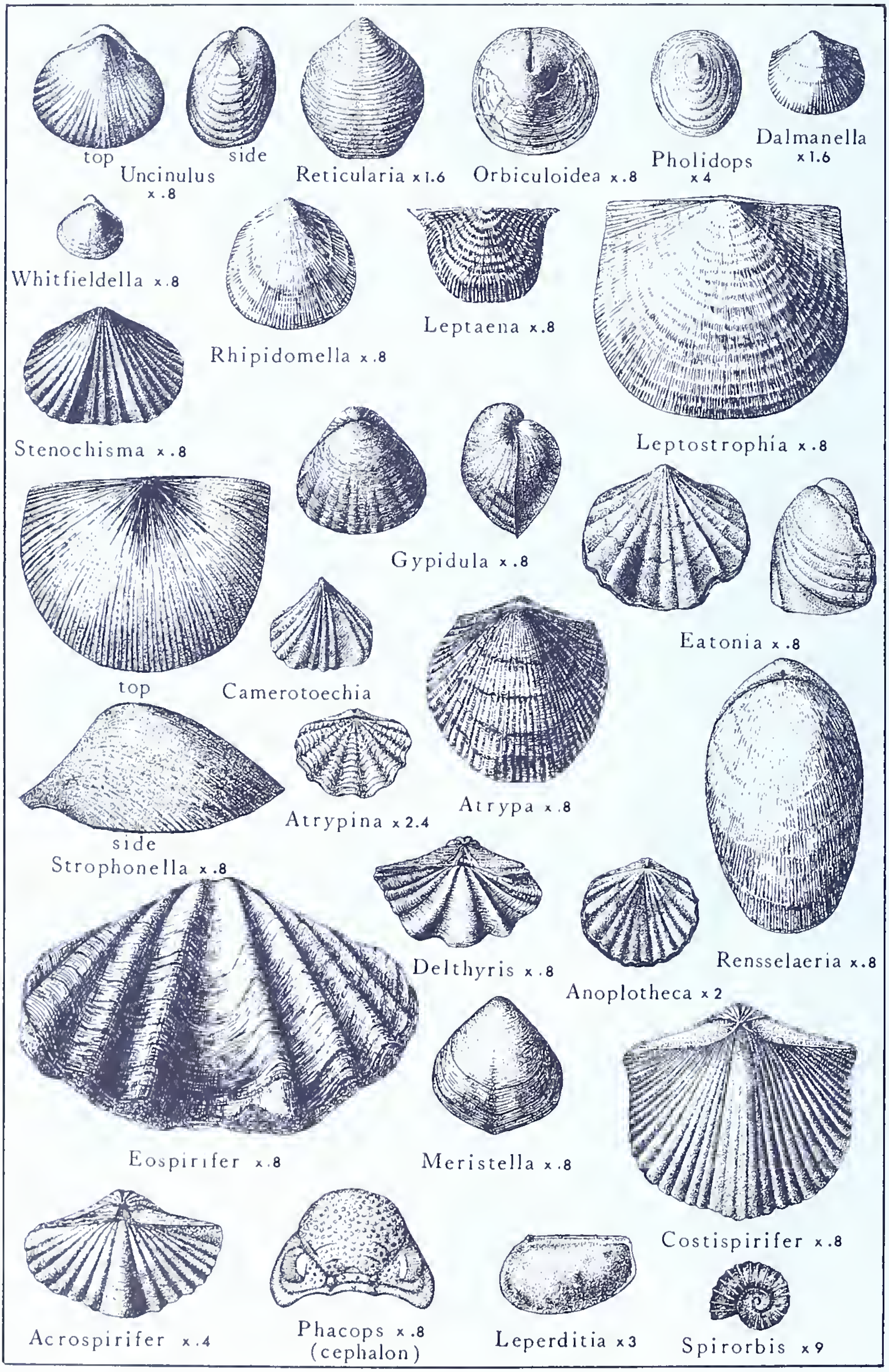


Velibeyrichia x13

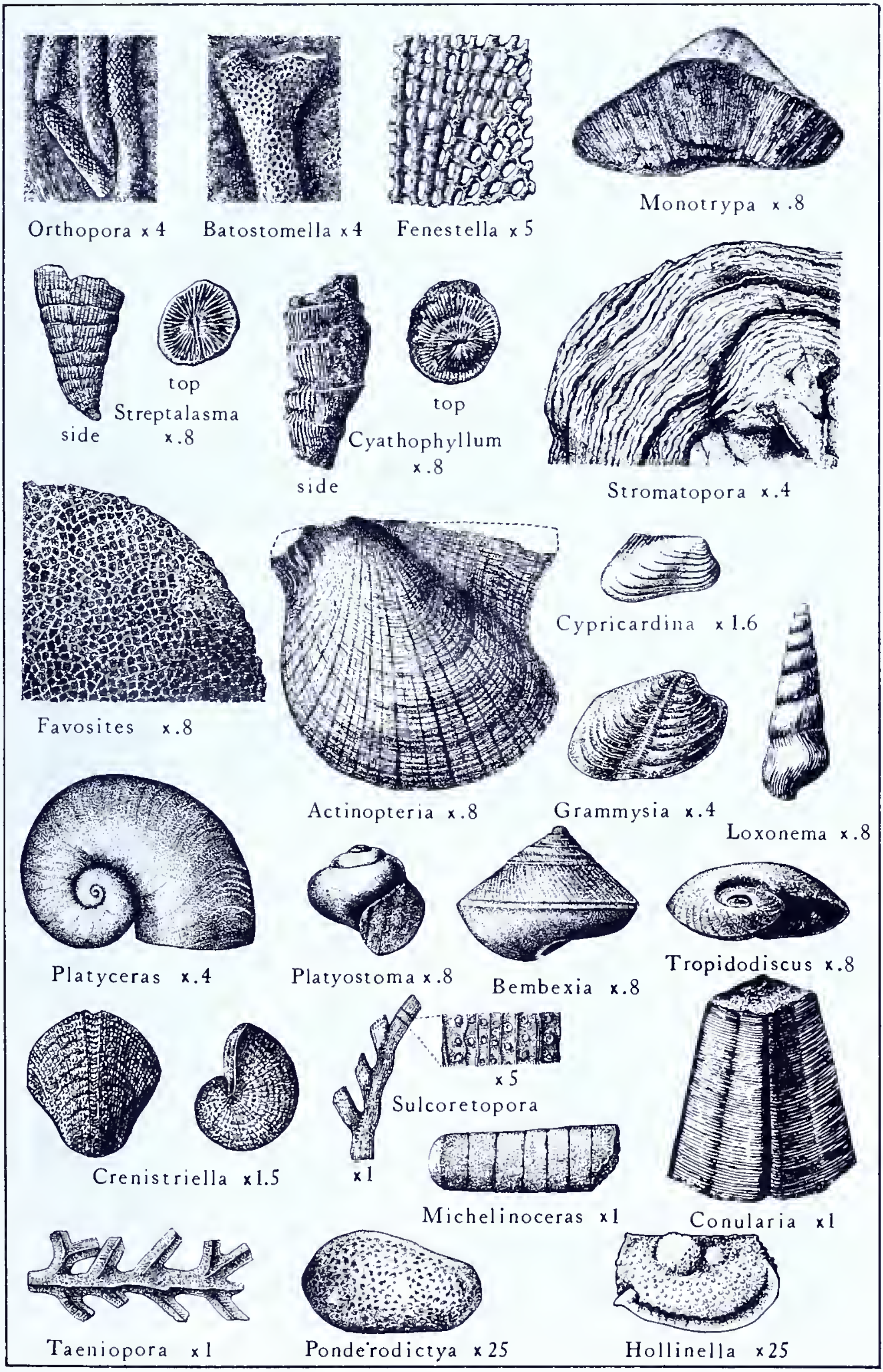


Stegerhynchus x.8

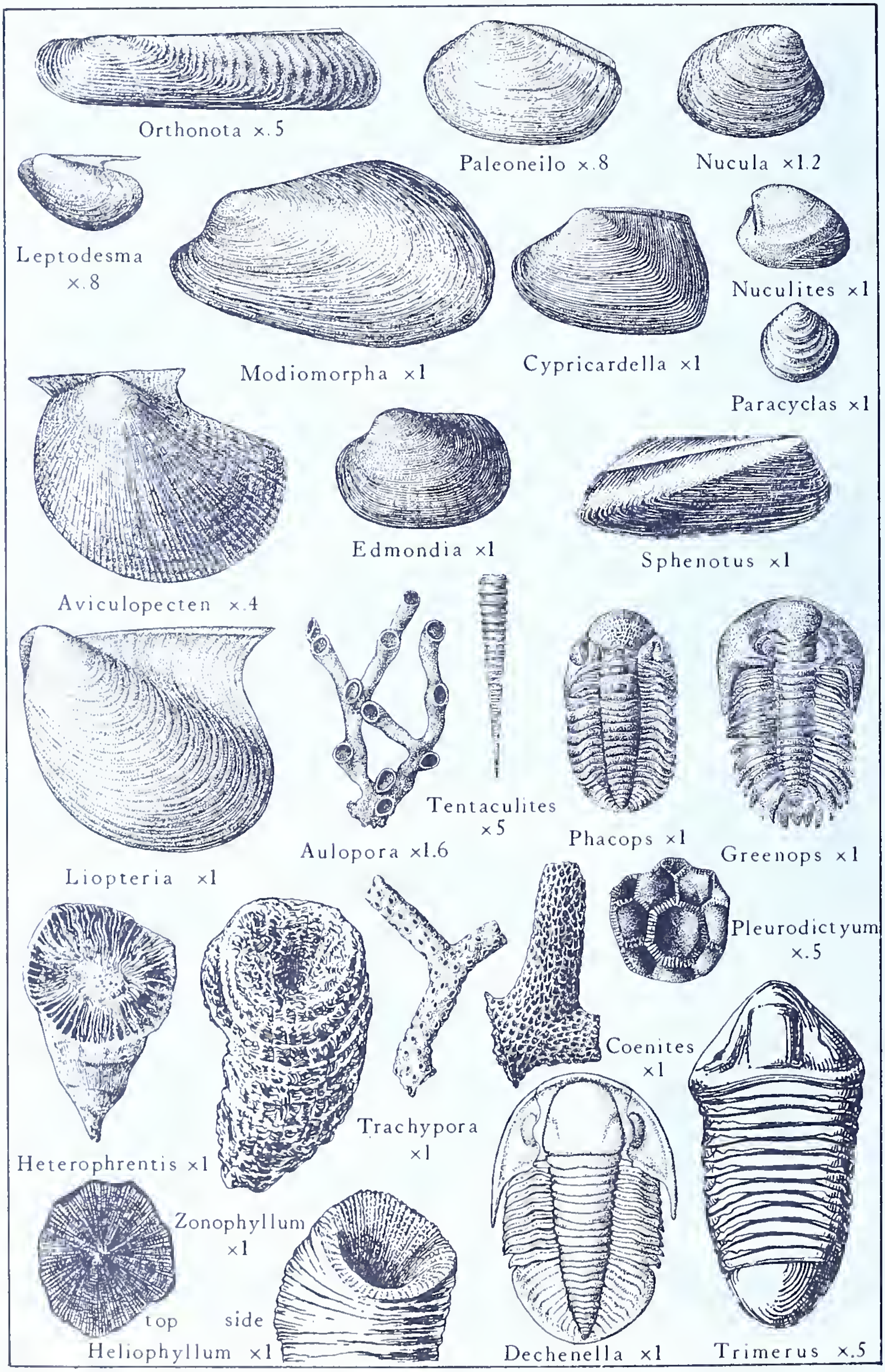
SILURIAN & DEVONIAN FOSSILS Plate 4



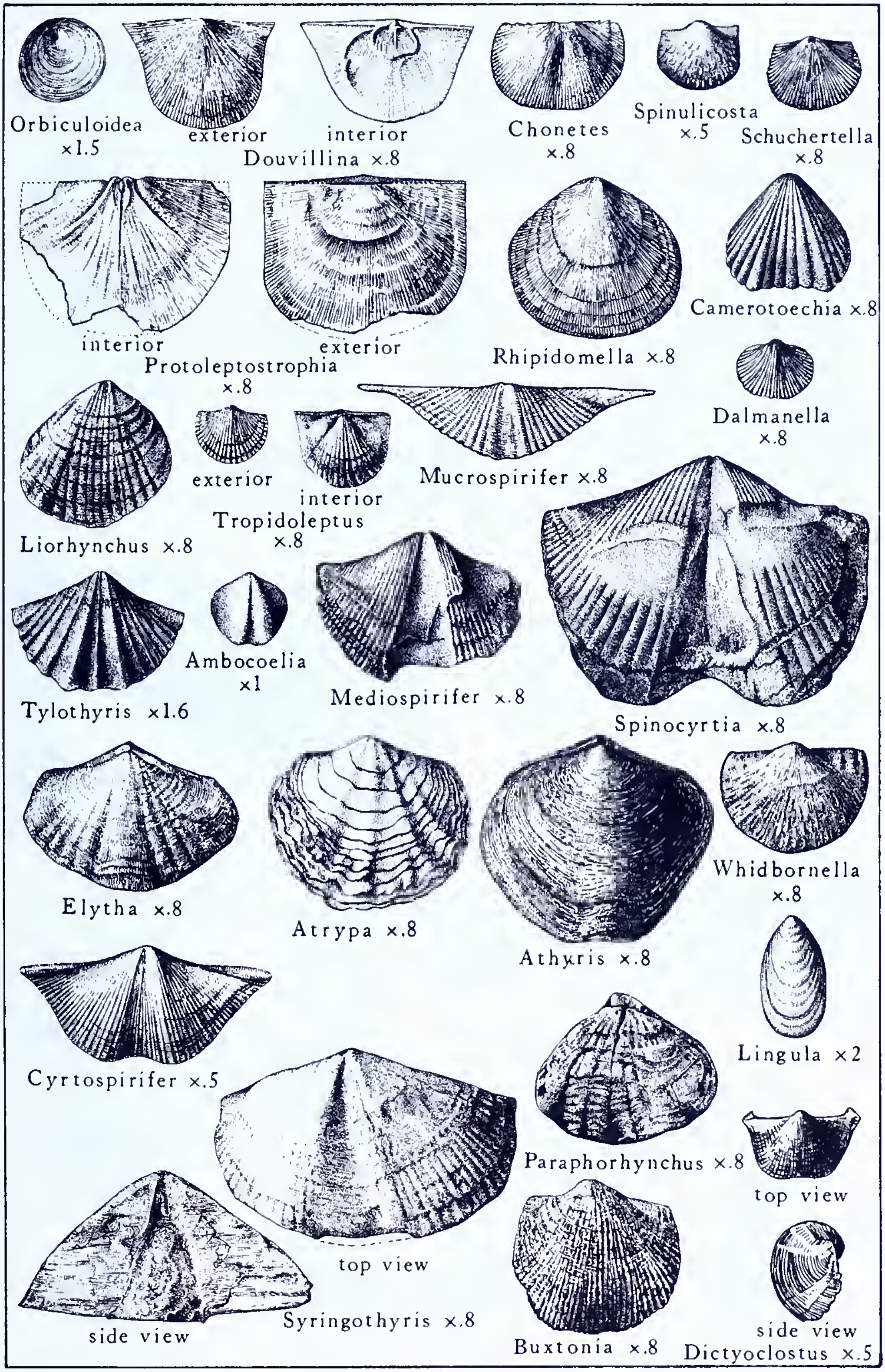
SILURIAN & DEVONIAN FOSSILS Plate 5



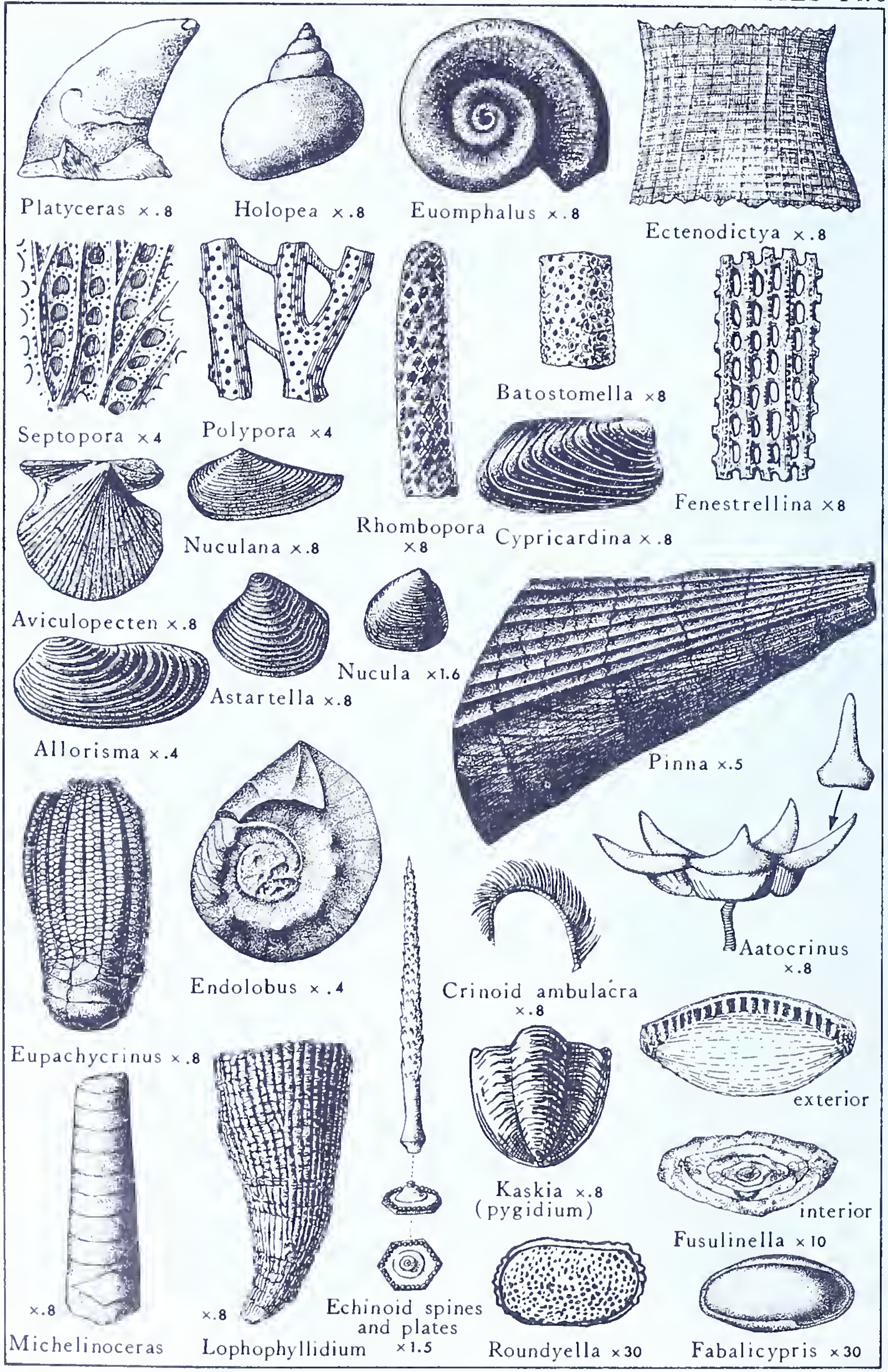
DEVONIAN FOSSILS Plate 6



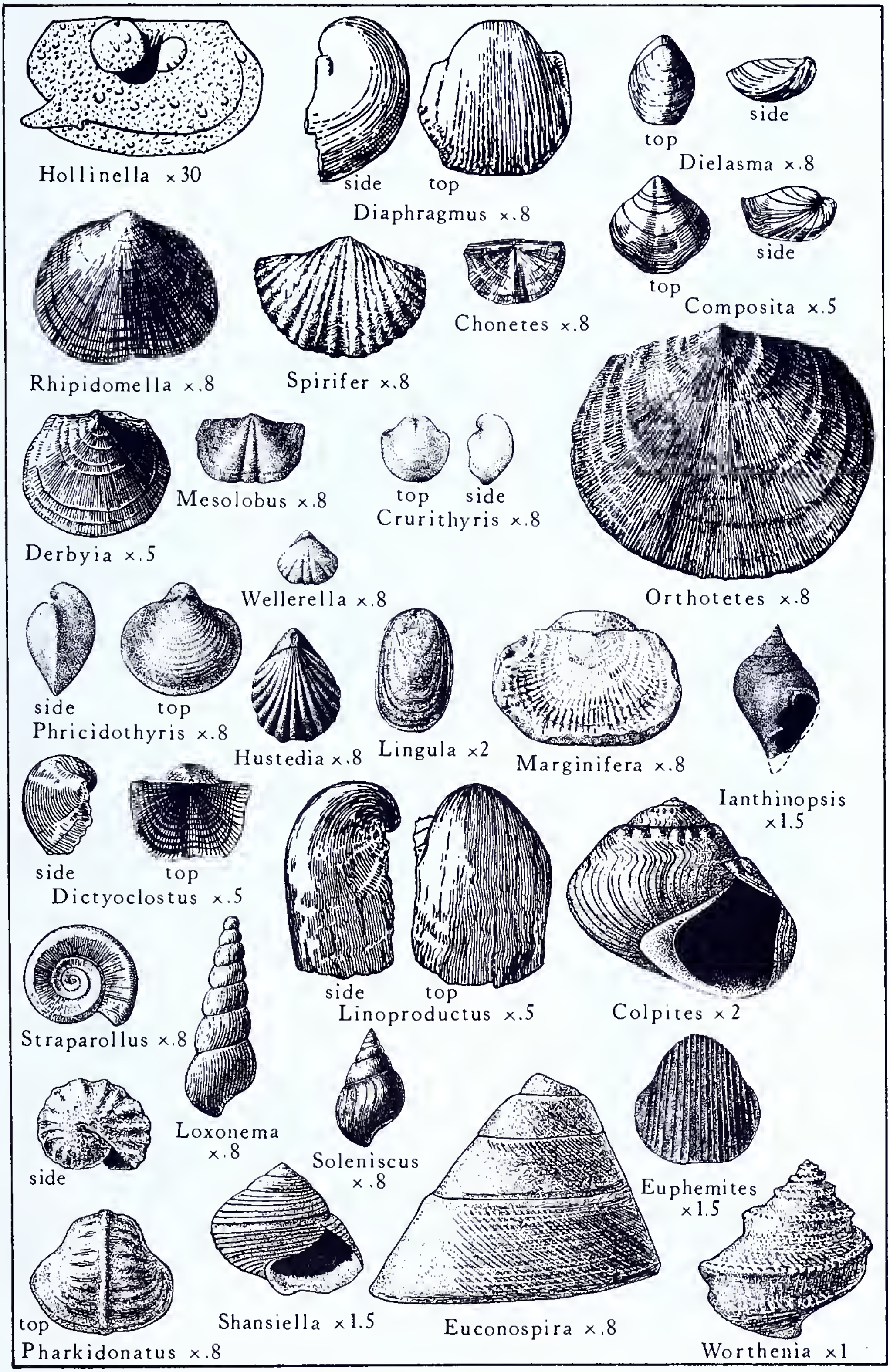
DEVONIAN FOSSILS Plate 7



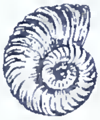
DEVONIAN, MISSISSIPPIAN & PENNSYLVANIAN FOSSILS Pl. 8



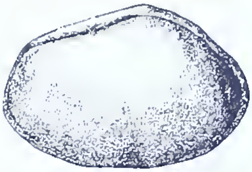
MISSISSIPPIAN & PENNSYLVANIAN FOSSILS Plate 9



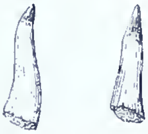
PENNSYLVANIAN, PERMIAN & TRIASSIC FOSSILS Plate 10



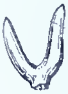
Spirorbis ×5



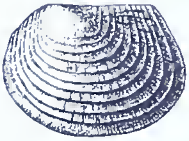
Cytherella ×35



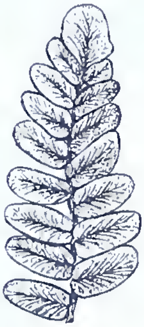
Paleoniscus ×4



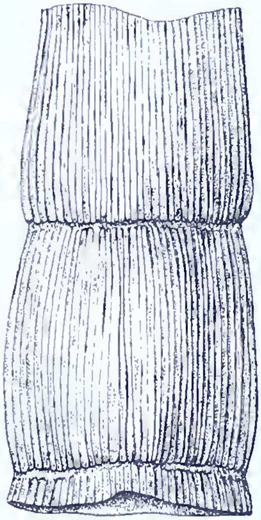
Diplodus ×6



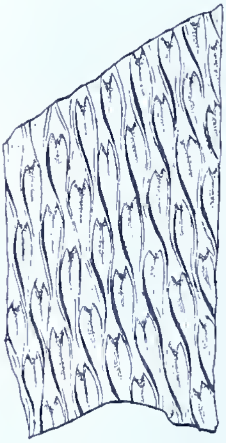
Pseudoestheria ×6



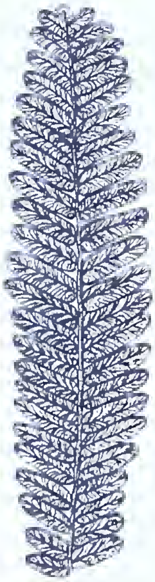
Neuropteris ×.4



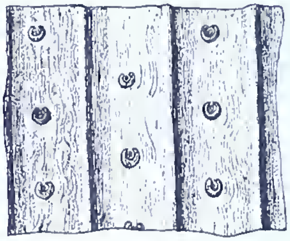
Calamites ×.5



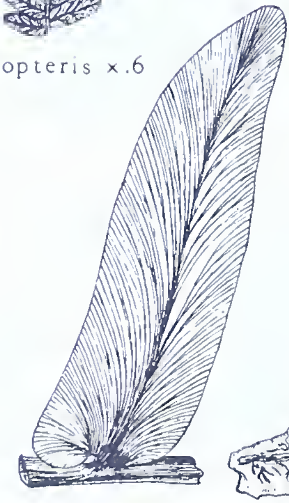
Lepidodendron ×.5



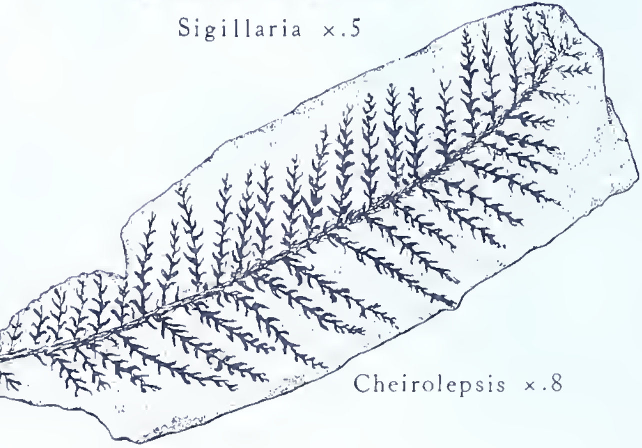
Pecopteris ×.6



Sigillaria ×.5



Neuropteris ×.8



Cheirolepsis ×.8